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Introduction of the Carman Lecturer

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LADIES AND Gentlemen—Members of the Radiological Society of North America, Friends, and Guests: It has been traditional in the Annual Meetings of the Radiological Society of North America to devote Tuesday evening to the Carman Lecture. It is fitting that on the present occasion this lecture to the Radiological Society of North America honoring the name of a great pioneer radiologist, Dr. Russell D. Carman, should be given by another pioneer in radiology. He too has prepared the way in radiological practice by many startling and epoch-making accomplishments. In this right we class him among the pioneers.

Born to lead and steadfast in his concept of ideals but ever mindful of practical reality, he has long commanded the profound attention of his listeners. The diversified interests which have occupied his time during his professional career are clearly exemplified in the wide range of subjects covered in his many publications. His thoughts on radiological diagnosis, radiation therapy, and medical philosophy have seemed to clamor for written expression through nearly forty years of radiological practice. Little wonder that Dr. Robert Newell, in writing a biographical sketch of this distinguished radiologist more than a decade ago, stated that up to that time he had not counted the papers in RADIOLOGY and elsewhere bearing his name.

The last ten years have brought no surcease in his scientific contributions, and the expressions of his profound philosophy have given him, in the minds of many, the attributes of a seer. With forthrightness, thoroughness, and urbanity seasoned with the spice of factual perception, he has more than once helped stay the onslaughts of political ambition in medical practice both in his home state and nationally.

For these and many other reasons, this Society is to be congratulated that one of its Past Presidents, a recipient of its Gold Medal, a man on whom many scientific societies in this country and abroad have bestowed their highest honors, is himself bringing honor to this organization by delivering its twenty-first Carman Lecture. His subject is "Science and Solitude versus Clinical Consultation." Dr. Lowell S. Goin!

Lowell S. Goin, M.D.

Carman Lecturer

Science and Solitude vs. Clinical Consultation

The Carman Lecture[1]

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THERE IS AN OLD proverb which says "An humble heart is the beginning of wisdom," and it is with this in mind that I take my place behind this desk to deliver the twentieth Carman Lecture. I am sensible of the honor that has been done me by our President, of the distinguished character of the audience before me, and of the illustrious men who have preceded me here, and these combine to form a quite understandable basis for the genuine humility with which I approach this task.

As to my subject, I shall not attempt to expound upon its importance, since to do so would serve only to bring into strong relief the weakness of the exposition. I shall, therefore, proceed at once to make Dr. Carman a sort of text for the remarks that I intend to make.

Dr. Russell D. Carman was one of the truly great men of our profession. A pioneer in the field, he was blessed with unusual powers of observation and with a reflective mind which transformed his observations into theories and dogmas which became important parts of the organized knowledge that today we call Radiology. To Dr. Carman, with Lewis Gregory Cole and James T. Case, we owe the greater part of our fundamental knowledge of the radiology of the gastrointestinal tract. He was a great radiologist, a great physician, and a great man. To most of you, I suppose, he is only a revered name; to some of us he is a remembered friend. I first knew Dr. Carman in 1910, and the circumstances of my earliest meeting with him are of interest because they afford such an amazing contrast with our professional environment of today and because they serve to bring into sharp focus the enormous strides of Radiology in the intervening forty-six years.

In 1910, I was a student in the School of Medicine of St. Louis University, where Dr. Carman was Instructor in Medicine and Professor of Roentgenology. On one gray winter day there was posted on the bulletin board of the school a notice advising students that at four o'clock that afternoon, at the City Hospital, Dr. Carman would make an x-ray examination of a hip, and that those interested might go to see this done. How curious that only forty-six years ago a procedure which is today so matter-of-fact and of such everyday occurrence was so unusual as to elicit a special notice!

To the students and, indeed, to the physician of that day, the scene was impressive. Snarling flames leaped across a spark-gap; gas tubes glowed with lavender light and were rejected as "too soft," *i.e.*, their resistance was too low to permit the production of x-rays with sufficient penetrating ability; finally a tube was selected and positioned over the patient, a glass plate enclosed in paper envelopes was slid into a tunnel previously placed beneath the injured hip; a switch was closed and the tube glowed steadily for perhaps fifty to sixty seconds. The plate was developed by rocking it in a tray of developing solution and, since Dr. Carman disappeared into the darkroom with the plate, it seems likely that he carried out this operation with his own hands. Finally he reappeared and demonstrated to the awed onlookers that the patient had sustained a fracture of the femoral neck.

I have drawn this picture in some detail for two reasons. One is to emphasize the tremendous contrast between this pro-

[1] Presented at the Forty-second Annual Meeting of the Radiological Society of North America, Chicago, Ill., Dec. 2-7, 1956.

cedure and the commonplace, utilitarian, and quite unnoted routine examination of the hip as you practice it today. What is much more important is that on that winter day in 1910 Dr. Carman employed a rather new modality for the examination of an injured human being and arrived at an incontrovertible diagnostic conclusion. But note, please, that it was not a young man in a white jacket, that it was not a woman in a starched uniform, who did this. This was Dr. Russell Carman, who in his own person saw, talked to, and examined the patient. This patient was under no illusion as to who it was that had examined him, and *who* had correctly diagnosed his injury. He did not believe that an x-ray department was a sort of unusual photographic studio, where a pleasant young woman made a picture for the information of his attending physician. That patient *knew* that he had been seen, and that he had been examined, by a medical specialist named Dr. Russell Carman.

Here it may be well to recall the origins of our specialty; to reflect upon how Radiology began, and who became our first radiologists, and why they entered this field. I do not pretend to be a historian and I speak now under correction, but perhaps our first or, at least, one of our first radiologists was Dr. Walter Dodd at the Massachusetts General Hospital in Boston. In the very early days, perhaps in 1896 or 1897, a Doctor Fitz, a Boston internist, returned from Europe with some x-ray apparatus. Walter Dodd was the hospital pharmacist and, since he was a pharmacist, he had scales suitable for weighing chemicals and hence seemed to be the obvious person to make the developing and fixing solutions. Next, it seemed logical that he should develop and fix the radiographic plates that were made from time to time. Presently the staff physicians, realizing that Walter Dodd had the opportunity of seeing many more of these plates than any one of them had, began to ask him his opinion. Thus was our specialty born. The advantage that Walter Dodd has, each of us still has. If one of us examines a chest for each of ten referring physicians, obviously that one of us has seen ten times as many chest films as any single clinician. Realizing his need for a medical background, Walter Dodd studied medicine and returned to the Massachusetts General Hospital as its first radiologist. Dr. Eugene Caldwell, who is commemorated annually with the Caldwell lecture of the American Roentgen Ray Society, was an electrical engineer whose knowledge and understanding of that subject led him to become interested in the production of x-rays, and was another pioneer who became a very early radiologist. Here, then, are the beginnings of our specialty; a division of medicine which came into being within the lifetime of many of us here present.

Our modern hospital problems—those continuing struggles between hospital administrators and radiologists—have an origin not entirely dissimilar. It is important to remember that no one can be blamed for these problems; they were not willed into being by anyone and they arose from no ulterior motive. Our specialty grew with such astonishing rapidity that without anyone ever having thought very much about it, the problems were there. Our early efforts in the field of diagnosis were largely the recognition of fractures and the presence of foreign bodies. Our therapeutic field was almost completely limited to the palliation of rather hopeless disease. The hospital basement seemed to be a reasonable location for such relatively unimportant activities and, since the rewards were largely spiritual, the question of fiscal arrangements seemed to deserve little discussion.

Then, almost before we knew it, radiology ceased being a rather bizarre procedure, used occasionally as an auxiliary in diagnosis, and became an important method used with increasing frequency by all branches of medicine. As its scope increased, its position in the physical environment of the hospital became important, more and more space was re-

quired, more and more assistants were needed, and conflicts over these matters began to develop, conflicts which persist to vex us now. Their ultimate solution will, I am persuaded, be determined by the position that the radiologist assumes, not only in a particular hospital, but in our broad professional world. I submit, ladies and gentlemen, that since that day when Dr. Carman made the examination I have described, we have come a long way.

Unfortunately, like the medieval knight who, fully armed, came out of his castle, looked around and rode off rapidly in all directions, we have gone forward in some ways, and, I am afraid, backward in others. Our technical advances are tremendous. We have contributed our share to the steadily increasing sum total of human knowledge. In a most matter-of-fact way we carry out procedures undreamed of in the early days of Dr. Carman's career. But we have paid for these things with our steady retreat into the world of the slide-rule, and of logarithms, of intricate calculations, and of solitary reflection upon the nature and possibilities of the shadows confronting us in a radiograph. We are exhibiting what I believe to be a lamentable tendency to withdraw more and more from the world of clinical medicine, from contact with patients, and even from the attending physicians whose patients we are examining and treating.

I realize full well that, in the busy world of modern Radiology, it is practically impossible for any radiologist to see personally every patient who comes to his department. I realize, too, that absolute justice and absolute virtue are goals impossible of achievement, but they remain goals to be striven for and, in our efforts to attain them, we are almost certain to make some progress toward the desired ideals. Thus, the fact that none of us can possibly see and talk to every patient entering our departments is no justification for the growing practice of never seeing any of them. That not every patient examined has findings worthy of discussion with his attending physician cannot be rationalized into never bothering with such a discussion. I do not mean to imply that these are universal customs, or that there are not many clinical radiologists who strive mightily to be, and to remain, good clinicians. I know that there are, and that some of the most distinguished members of our profession are widely known and greatly respected for their clinical ability and their intense interest in their patients. But I might draw a homely parallel here and say that one need not conclude that a barrel of apples is spoiled because there is a rotten apple in it. You all know, however, that the entire barrel *will* spoil unless the offending apple is removed. My plea is, then, that we be clinicians, that we see patients, that we function as consultants, and that a good part of our time be devoted to the discussion of cases with our referring physicians.

For some years past I have been deeply shocked from time to time at being assured by a technician being interviewed that she had done all of the therapy at St. Blank's Hospital for several years. I have been even more shocked to find, subsequently, that she had, in fact, done the therapy; that is to say that she had treated patients; to find that a physician, not infrequently a respected colleague, had delegated this enormously important function, the very core of medical practice, to a technician. I cannot believe that a radiologist is truly functioning as such when he is satisfied to write a prescription for radiation therapy and to hand it (and a sick and frightened patient) over to a technical assistant. I have said before, and I say again, that it is, or that it certainly should be, our purpose as physicians to deal with a sentient being, filled with hope and despair, with fears and doubts, and that we must deal with him as a personality, requiring not merely repairs but sympathy, understanding, and even affection. These are the prime functions of physicians, and unless we are physicians most of the meaning departs from our specialty.

Reflective logic is that branch of organized thought which seeks to bring problems to some reasonable solution by orderly reflection upon them. Although it is a process requiring some mental effort and concentration, it is not infrequently a rewarding exercise and it may perhaps be worthwhile to attempt reflection upon certain of the problems that vex us. Some of these are problems peculiar to our specialty; some are common to the entire profession of medicine; and some simply mirror the times in which we live.

I wonder if we do not have a tendency to ignore certain trends which seem to me rather portentous and to cast an ominous shadow across our future. I shall mention them because they appear to bear a very direct relationship to the problems at hand. When Dr. Carman made the hip examination which I have described, it required a certain amount of courage and ingenuity, and a good deal of knowledge in several fields—electrical engineering, physics, and chemistry, for example—even to produce a satisfactory radiograph. Not many of you, I suppose, have had to struggle with a refractory gas tube, attempting to adjust its vacuum to a proper level for the task at hand. Not many of you have wrestled with a Wehneldt interrupter, or have loaded a glass plate into a black envelope and it into an orange envelope. Few of you have even seen a spark-gap or have rocked a plate in a tray, watching eagerly to see an image appear. All of these things were commonplace to every early radiologist. As time has gone on, apparatus has become more efficient, simpler, safer, and easier to use, until today a salesman can, in an afternoon, teach an office nurse to produce a radiograph which is at least recognizable as representing say a chest or a pelvis. If you will look at the advertisements appearing in medical journals, especially those not devoted to radiology, you will observe that the manufacturers of x-ray apparatus lay great stress on this simplicity, indicating that, with the particular equipment being offered, almost anyone can produce fine radiographs. For his prestige, and perhaps with an eye on his income, the general practitioner in steadily increasing numbers is installing such apparatus. He soothes his professional conscience by maintaining stoutly that he intends to do only simple things and that he is resolved to refer all problems to a radiologist, ignoring the fact that when one knows that a problem *exists* one is well on the way to an intelligent diagnosis. This, of course, is making increasing inroads on the field of the radiologist.

This is not intended as an economic complaint. Actually, there are not enough radiologists to do all the radiology that needs doing. The harm here is twofold. Inferior diagnostic ability leads inevitably to lower standards of medical care. The Elizabethan poet and preacher, John Donne, said that, being involved in mankind, he was diminished by the death of every man. The stature of Radiology is lessened by every person who, satisfied with his own ability, is content to by-pass the radiologist. Whether this becomes a serious threat to our profession will be determined by the amount and the character of service that we can offer to the conscientious practitioner of medicine. Nearly all urologists and orthopedic surgeons, and many chest physicians and thoracic surgeons, do their own radiology in their own offices. Most of them do it extremely well within the confines of their own specialty, but with only negligible exceptions they lack the breadth of vision and the extraordinary co-ordinating ability of the well trained and experienced radiologist. Their efforts then do not, or at least should not, serve to make unnecessary the labors of the radiologist.

Aside from the probable lowering of the standards of medical care by the loss of a certain amount of diagnostic skill, there are two sound reasons why the specialist, however expert in his own field, must never supplant the radiologist. The first is that not all patients go to specialists; of those who do, not all are able to select the special fields within which their particular

ailments may lie. These constitute a group who may profit greatly by the services of a radiologist. The second reason is that the specialist very often has a sort of tunnel vision; his attention is directed to his own field while he remains almost unaware of, or at least ignores, the bordering areas and their not infrequent interrelationship. Thus, an excellent chest physician failed to observe the extensive destruction of a second rib, since his attention was centered completely on a small pulmonary lesion on the opposite side. Thus, a competent gastroenterologist searched so carefully for an ulcer penetrating into the pancreas which would explain his patient's constant boring back pain that he failed to observe the osteolytic lesion in the first lumbar vertebra. I need not expand this subject; everyone of you has encountered many similar examples of this narrow outlook of the limited field worker.

Nevertheless, there is a problem as to what the radiologist of the future shall do. Will there remain a field for him or will he be reduced to a mere administrator of an x-ray department, a sort of co-ordinator of its activities? Some radiologists have already accepted this state and appear to be quite resigned to it and quite undisturbed by it. Is this a common situation? Am I crying "Wolf! Wolf!" when the creature is only a lapdog? Am I setting up a straw man and valiantly tilting at him? Not long ago a radiologist told me that he didn't like therapy because he didn't like to bother with patients. This, of course, is only a roundabout way of saying that he did not like the practice of medicine. A radiologist, now dead but well known to many of you, told me that, if the hospital staff would stay out of his department, he could get his films read and his reports dictated. He was completely unimpressed by my insistence that consultation with the staff members was by far his most important function. He was deeply wounded and amazed when he was replaced and was never able to understand why the hospital staff had not rallied to his support. I know a large department in which all cases are reported by the senior resident and in which the chief never sees a patient and rarely examines a film. I know an even larger department in which an attending man almost never sees a radiologist. The reports for the patient's chart are turned in approximately five days after the examination and, in the meantime, the internist or the surgeon looks at the films, decides upon the diagnosis, and proceeds with the management of the case.

Is it unfair to ask just what function the radiologist has exercised? Except to manage the department, secure the supplies, direct the technicians, and see that the equipment functions, just what *has* he done? Is it remarkable that the attending staff becomes increasingly willing to by-pass him and to rely more and more on their own judgment? And, if this becomes a widespread practice, what need will there be for the radiologist? Why might not an experienced and mature chief technician direct the work and behavior of the technical staff and see that good quality films are produced for the study of the referring physician? A prominent hospital on the West Coast has a radiologist who says that a neurosurgeon who desires a myelogram may himself inject some opaque material and the department will make the films. Is this good myelography? Is it even good radiology? A well known radiologist told me that he always had an intern inject the opaque medium for excretory urography because he did not want to assume any responsibility for an untoward reaction. Is this good radiology? Is this any branch of the practice of medicine? One might multiply these examples almost indefinitely but I think that these will suffice.

By way of contrast, let me give you what I think is an outstanding example of superior clinical radiology. One of the most distinguished radiologists of our country was asked to re-examine the stomach of a man complaining of upper left quadrant pain, who was suspected by

the previous examiner of having a tumor in the region of the cardia. The radiologist was quite unimpressed by the findings in the stomach but, on questioning the patient carefully, found that the pain was not exactly in the upper left quadrant but that it swept around the lower left chest. Armed with this information, apparently not elicited by anyone else, he took a needle and pricked out an area of paresthesia extending from the thoracic spine to the upper left abdomen. Radiographic examination of the spine disclosed a destructive lesion involving the left pedicle of the eighth thoracic vertebra and a tumor was resected at that level. This is true clinical radiology, and the life-saving diagnosis could have been made only by an examiner who was not solely a radiologist, but a clinician. The most remarkable thing about this incident is that the radiologist did not seem to think that it was at all unusual. That is to say, he was a physician highly trained in radiology, but he *was* a physician. If I may quote the words of the Gospel, I will say that "this man went down into his house justified, rather than the other." This is the sort of radiologist who fills a definite place in the medical world, the sort of radiologist who is essential to good diagnosis and hence to good medical care. This is *not* the radiologist who reviews films and dictates a report five days after the patient has had an unnecessary exploratory laparotomy and possibly a total gastrectomy for a tumor of the eighth thoracic vertebra.

In the Book of Ecclesiastes it is written: "One generation passeth, and another generation cometh, but the world abideth forever." Well, my generation of radiologists, which began with the glass plate, the induction coil, and the gas tube, is passing and the generation of younger radiologists, the generation of angiocardiography and radioactive cobalt, is arriving, and the world does abide. But it is not quite the same world. Our civilization, our economy, and our culture are changing; the nature of medical practice is changing, and our specialty is changing with it. Change seems to be much admired today and to resist it, or even to deprecate it, is hazardous and will likely result in one's being designated as an old fogy. And yet, change is not in itself necessarily good. Its value depends entirely upon what is being accomplished; what benefit is being received in exchange for something discarded. Certainly progress depends upon change, but it is not true that change is identical with progress or that every change represents an advance into a better world.

When patients have been changed into cases—or even into case numbers—when the clinical art of medicine has been abandoned for the purely scientific approach, is it certain that we have advanced the cause of good medical care? When the physician, engrossed with such genuine essentials as electrolyte balance, hormone levels, and pulmonary artery pressures, no longer has the time to listen sympathetically to the patient's problem (quite possibly a rather trifling problem), to whom shall the patient turn? When the radiologist, deeply and seriously concerned with the physical factors of radiation, with the administration of a lethal dose of radiation to cells in a particular nidus, has neither the time nor inclination to reassure the patient, to explain the error of the neighbors' opinion, and to give him encouragement and hope, will not the patient turn to the unctuous and false persuasions of the cancer-cure quack? Of course these things will happen, and we have a deep moral duty to do our best to prevent them. The only way that we can reach this devoutly to be wished for consummation is to be and to remain clinical consultants; to be and to remain good physicians. Change, however, is occurring, and the position of our profession and particularly of our specialty in this changing order is of enormous importance to us. There are those who believe that the future is predetermined and that what we say or

do will have little effect. I do not accept this belief in its entirety. Instead, I maintain that, although we may not have complete control over events to come, the future is a malleable thing and we may influence it in many ways; that our thinking and our conduct here and now may well have very potent effects upon our future development.

In this thinking and in this conduct I include first of all being a good physician and, after that, a good radiologist. Such a man should be a valuable addition to the diagnostic team and one of the most useful consultants in the management and the therapy of malignant disease. He should be a student, and a man who applies himself diligently to every problem that presents itself. He should make a serious effort to see and to talk to every patient about whom he expects to give an opinion. He should do whatever seems necessary or desirable for the formulation of a valid diagnostic conclusion, and should not content himself with studying a group of radiographs. I do not believe that a clinical radiologist who has talked to a patient with a painful shoulder and has found point tenderness over the trapezius and pain referred down the radial nerve will be content to report as negative the shoulder examination requested. He will, on the contrary, investigate the cervical spine and, very likely, will identify the source of the nerve root pressure producing the pain. In short, he should be and, if our specialty is to survive, he *must* be a clinician who is well trained in the special field of radiology.

I include, also, taking one's place in the professional world to which we belong and interpreting that place as concerned not only with the strictly professional but with the political and economic as well. Let us remember the admonition of Plato, that if a man scornfully refuse his call to govern, it will be his fate to be ruled by a worse one. Let us, then, take our places in the world of organized medicine, representing our specialty proudly and efficiently. Let our voices be heard in the councils of our profession, pointing with pride to those things which we have achieved.

I include the assumption of the role of consultant and the participation in vigorous informal debate conducted daily in the consulting room. I include the taking of histories and the physical examination of patients whenever it appears that the information gained will help in arriving at a sounder conclusion. Let us take our places at ward rounds, at clinico-pathological conferences, at meetings of the various sections of our hospital staffs. There let us freely confess our errors, and there let us stand sturdily by our valid conclusions, neither hesitating to defend our opinions nor to accept opposing ideas when the weight of evidence favors them. Thus we shall function as clinical consultants; thus we shall win and maintain the respect of our colleagues in the broad field of the medical and surgical specialties.

In short, I include the behavior of a skilled practicing physician and maintain that this is or should be the goal of everyone of us. Ten years ago this month, addressing this Society, I said what I would like to repeat now, that "upon such a foundation Radiology may erect an even more imposing structure than it possesses now. But the necessity is urgent; radiologists must be clinicians." This is what I am urging tonight: that, if there be radiologists enclosed in ivory towers, they come out and make themselves part of the world to which they belong. Thus we may hope to survive as a free specialty, but unless we are prepared to render service superior to that which a man well trained in his own field can reasonably hope to furnish for himself, we will lose our reason for being and our specialty will perish.

Lord Francis Bacon closed one of his essays with words of such wisdom that I should like to employ them here. "No man can," he said, "by taking care, add a cubit to his stature in this little model of a

man's body. But in the great frame of kingdoms and commonwealths it is in the power of Princes and Estates to add amplitude and greatness to their kingdoms. For by introducing such ordinances, constitutions and customs as we have now touched, they may sow greatness to their posterity and succession. But these things," he added "are commonly not observed, but are left to take their chance."

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SUMMARIO IN INTERLINGUA

Scientia e Solitude aut Consultation Clinic: Le Discurso Carman

Quando in 1910 Dr. Russell D. Carman, in memoria de qui le Discursos Carman esseva establite, executava un examine a radios X in un caso de un coxa ledite, il esseva ille mesme qui parlava al patiente, qui examinava le, qui disveloppava le placa, e qui formulava le diagnose.

Per contrasto con isto, il ha hodie un troppo marcate tendentia del parte del radiologo de abstraher se de plus in plus ab le mundo del medicina clinic, ab contactos con le patientes, e mesmo ab le medico tractante qui invia su patientes a ille pro examine o therapia.

Ben que alterationes in le position del profession medical in general e del specialitate radiologic in particular es inevitabile in iste mundo vacillante, le radiologo ha le possibilitate de exercer per su attitude e su comportamento un effecto potente super le disveloppamento futur. Ante toto ille debe esser un bon medico e postea un bon radiologo. Ille debe concerner se con le aspectos politic e economic de su profession. Ille debe acceptar le rolo de un consulente e parlar in terminos decidite in le sala de consulta. In breve, ille debe jocar le rolo de un expert medic.

Cerebral Angiography in Encephalo-Trigeminal Angiomatosis[1]

CHARLES M. POSER, M.D.,[2] and JUAN M. TAVERAS, M.D.

ENCEPHALO-TRIGEMINAL angiomatosis, as we understand it, consists essentially of a vascular anomaly of the skin of the face, in the area served by the trigeminal nerve, associated with a presumed intracranial vascular anomaly. Sturge originally described the syndrome as consisting of a facial nevus of the "port-wine" variety associated with an ocular abnormality, either buphthalmos or congenital glaucoma, and "cerebral involvement," such as focal convulsive seizures. Since that time, other features have been added to the syndrome and endless subtypes and eponymic designations have appeared. These have served little purpose except to sustain the impression, shared by most modern authors, that encephalo-trigeminal angiomatosis is but one manifestation of a generalized dysgenesis which, like all such congenital abnormalities, can take a variety of forms and present itself in a whole gamut of "completeness." We have used the term to include various vascular anomalies of the face, whether of the classical port-wine type or racemose angioma.

Relatively few cases of this syndrome have been studied by means of cerebral angiography. Egas Moniz stated that no angiographic abnormalities could be found in these cases, and Bergstrand, Olivecrona and Tönnis, and later Riechert, agreed with that conclusion. Many investigators have been reluctant to subject children to cerebral angiography. Until Torkildsen and Koppang's publication appeared in 1950, there was no report specifically devoted to the procedure in this early age group. A recent study by the present writers demonstrated that it is at least as safe in children as in adults.

Cerebral angiography has certain inherent drawbacks that may explain the disappointment of early investigators with this technic. Some vascular abnormalities are undoubtedly made up of vessels too small to opacify sufficiently to be seen on an x-ray film. A feeder vessel to a small lesion may be thrombosed and thus hide the latter during angiography. The introduction of serialograms obtained by rapid cassette changers and roll films has made possible a more complete visualization of the capillary and venous phases.

MATERIAL

We have collected 15 cases of encephalo-trigeminal angiomatosis which were subjected to cerebral angiography. All of these were studied at the Neurological Institute of the Presbyterian Hospital, New York. In addition, we have reviewed the available literature and found 37 cases—Sturge-Weber syndrome, encephalo-trigeminal angiomatosis, or some other designation—in which cerebral angiography had been carried out. Two of these cases (Cases 12 and 13 of DiChiro and Lindgren) are not included in our analysis, since there were no stigmata of the syndrome which would make them conform to our criteria for acceptance in this series.

CLINICAL FINDINGS

Our cases, as well as those collected from the literature, were divided into three clinical categories:

Type I: Typical Sturge-Weber encephalo-trigeminal angiomatosis: In all of these cases there are a port-wine nevus and at least two other features of the syndrome, as convulsions, hemiparesis, hemiatrophy

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TABLE I: CEREBRAL ANGIOGRAPHY IN ENCEPHALO-TRIGEMINAL ANGIOMATOSIS: 15 CASES STUDIED AT THE NEUROLOGICAL INSTITUTE OF NEW YORK

Case and Age	Calcification	Angiographic Group
Type I		
1. Ro. 11 mo.	0	I and IV
2. Fe. 5½ mo.	0	I, III and VI
3. Sc. 12 mo.	0	I
4. Da. 3½ yr.	0	III and VI
5. Re. 18 yr.	0	V and IV
6. Mo. 6 mo.	0	VI
7. Di. 2½ yr.	0	Neg.
8. Bu. 10 yr.	0	Neg.
9. Mi. 12 yr.	+	VI
Type II		
1. Ca. 7 yr.	+	I
2. Co. 9 yr.	+	Neg.
Type III		
1. Bi. 4½ yr.	0	I and IV
2. Om. 11 mo.	0	V
3. Sa. 6 mo.	0	VI
4. Ka. 2 yr.	0	VI

NOTE: All cases of Angiographic Group VI were cases of cerebral atrophy demonstrated by cerebral angiography.

or hemihypertrophy, mental retardation, buphthalmos or congenital glaucoma.

Type II: The incomplete form. Skin manifestations are absent, but other classical features of the syndrome are present. With a single exception, all the cases in this category showed the classical Weber type of calcification on x-ray films of the skull.

Type III: The so-called atypical cases. All cases in this group have some type of vascular anomaly of the skin of the face (but not the port-wine nevus) and other features of the syndome. The facial anomaly in one instance consisted of a raised hemangioma; in another, a network of tremendously enlarged veins involved the trigeminal area both in the skin and subcutaneously, while in a third case there was hyperpigmentation of the skin in the distribution of the trigeminal nerve. The cases are listed in Tables I and II.

ANGIOGRAPHIC FINDINGS

All patients in our group were studied by means of serial films made in frontal and lateral projections. Serialograms are, of course, essential for the study of this condition, since the abnormalities are visible in the capillary and venous phases of the angiogram. The findings on cerebral angiography were arbitrarily divided into six groups, designated by Roman numerals in the tables.

I. Intracranial Venous Angioma or Telangiectases: In this group there is a localized increase in the size and the number of veins (Fig. 1) and large capil-

TABLE II: CEREBRAL ANGIOGRAPHY IN ENCEPHALO-TRIGEMINAL ANGIOMATOSIS: 35 CASES FROM THE LITERATURE

Year and Author	Age	Calcification	Arteriographic Group
Type I			
1. 1935, Moniz & Lima	18 yr.	+	Neg.
2. 1936, Furtado	5 yr.	+	I
3. 1936, Olivecrona (Case 1)	27 yr.	+	Neg.
4. 1936, Olivecrona (Case 3)	13 yr.	+	Neg.
5. 1936, Olivecrona (Case 4)	35 yr.	+	IV
6. 1945, Green	3 yr.	+	I
7. 1947, Furtado & Rodrigues	8 yr.	+	III
8. 1949, Craig	4 yr.	+	Neg.
9. 1949, Lamy *et al.*	1½ yr.	0	I
10. 1949, Lamy *et al.*	13 yr.	0	I
11. 1949, Lamy *et al.*	8 yr.	0	Neg.
12. 1950, Eckel	64 yr.	+	Neg.
13. 1950, Torkildsen & Koppang	3 yr.	+	VI
14. 1951, DiChiro & Lindgren (Case 4)	2½ yr.	+	Neg.
15. 1951, DiChiro & Lindgren (Case 5)	28 yr.	+	Neg.
16. 1951, DiChiro & Lindgren (Case 14)	35 yr.	+	Neg.
17. 1951, Hunt & Moore	12 yr.	+	III
18. 1951, Sugar	1½ yr.	+	I
19. 1952, Contini & Leoni	18 yr.	+	Neg.
20. 1952, Zweymüller (Case 1)	10 yr.	+	Neg.
21. 1953, Laur	15 yr.	0	II
Presumed Type I			
1. 1944, Engeset	?	+	Neg.
2. 1950, Hebold-Koch	?	?	Neg.
3. 1952, Picaza	?	?	Neg.
4. 1952, Picaza	?	?	Neg.
Type II			
1. 1943, Sunder-Plassman	29 yr.	0	V
2. 1949, Curtis	19 yr.	+	I
3. 1951, DiChiro & Lindgren (Case 7)	25 yr.	+	Neg.
4. 1951, DiChiro & Lindgren (Case 8)	16 yr.	+	Neg.
5. 1951, Sugar	28 yr.	+	I
6. 1952, Zweymüller (Case 3)	9 yr.	+	Neg.
Type III			
1. 1933, Nicolato	25 yr.	0	Neg.
2. 1940, Northfield	9 yr.	0	II
3. 1942, Engelhardt	19 yr.	0	IV
4. 1951, DiChiro & Lindgren (Case 11)	21 yr.	+	Neg.

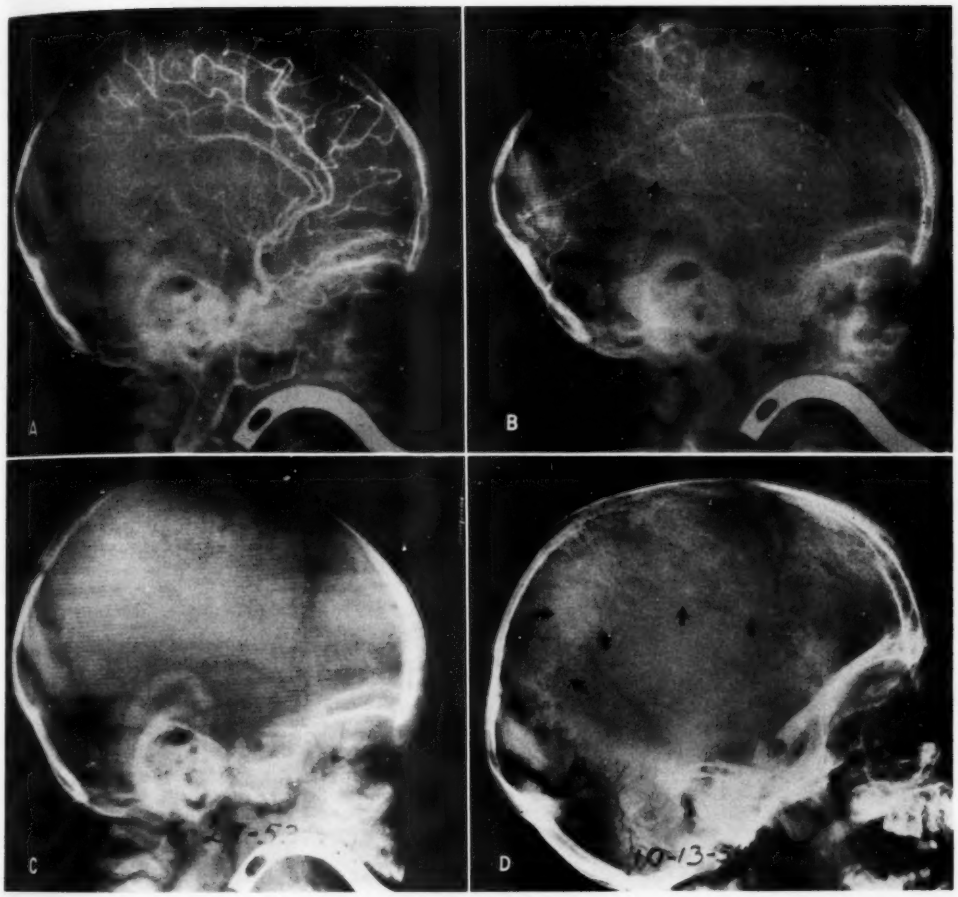


Fig. 1. A. Film of an infant of five and a half months made during the arterial phase of a cerebral angiogram.
B. Film of same child made at two and a half seconds, shows a group of veins in the parietal region which represents a capillary-venous angioma or telangiectasis.
C. Plain film of same patient shows no calcification. This was made at the time of angiography.
D. Rather extensive calcification has appeared fifteen and a half months later, chiefly in the parietal region in the same area in which telangiectasis was seen.

laries in the brain. The diffuse homogeneous increase in density (Fig. 2) is believed to represent an increased capillary bed. The arteries feeding such areas are not enlarged. These manifestations have been considered the typical angiographic findings in Sturge-Weber's syndrome. Five patients in our group of 15 presented this type of abnormality, and it occurred in 7 of the 35 cases collected from the literature.

II. Arteriovenous Malformations: Here the arteries which feed the abnormal areas are enlarged and abnormal, as well as the veins. This type must be very rare. No example was found in our group, and only 1 among the typical Sturge-Weber cases in the literature (see Table II).

III. Arterial Thrombosis: Thrombosis may involve major branches (Fig. 4) or it may be limited to smaller arteries and arterioles. In the latter case, the arteries which are actually occluded cannot be seen, but an area of relative avascularity represents occlusion of the arterioles supplying that area.

IV. Anomaly of Veins or Venous Sinuses: This anomaly may consist of large

Fig. 2. Vertebral angiogram of a boy three and a half years old with typical features of encephalo-trigeminal angiomatosis. There is diffuse increase in density of the occipital lobe on the right side in comparison to the other side, which may be due to a dilated capillary bed on the right side or to thrombosis of arterioles and a reduction of the capillary bed on the left side. The facial nevus in this instance was on the left side.

veins which course through the brain in unusual locations but do not form a conglomeration of abnormal vessels (Fig. 6B). Thrombosis (or agenesis) of dural sinuses is also included here (Fig. 5).

V. Abnormalities Within the Territory of the External Carotid Artery: These may be actual angiomas, composed of veins or capillaries, supplied by either the external or the internal carotid artery but located in a territory normally supplied by the external carotid circulation (Fig. 6B).

VI. Miscellaneous Abnormalities: Under this heading are included subdural hematoma and cerebral atrophy. The angiographic diagnosis of cerebral atrophy in children has been described by the present authors (Taveras and Poser).

Two or more angiographic features may be present in any given case.

AUTHORS' CASES

Our patients ranged in age from five and a half months to eighteen years, with only one above the age of twelve. Nine patients were classified as of clinical Type I (typical cases), 2 of Type II (incomplete forms), and 4 of Type III (atyp-

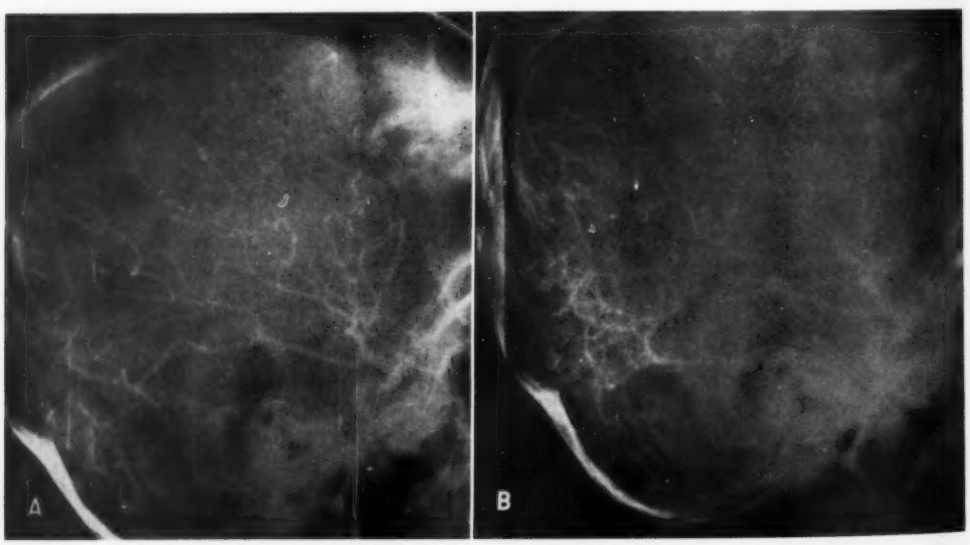


Fig. 3. A. Film made during the arterial phase in an eleven-month-old girl.
B. The film at two and a half seconds still shows a late arterial phase, but a conglomeration of "large capillaries" and veins occupies the entire occipital lobe.

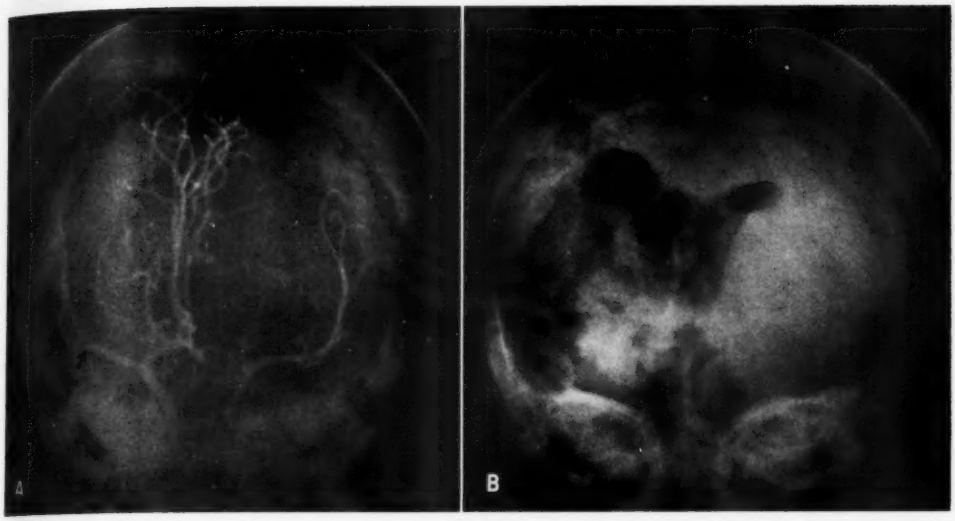


Fig. 4. A. Right carotid angiogram of an infant of five and a half months, showing good contralateral filling. There is thrombosis of the middle cerebral artery (arrow). Note shift of the anterior cerebral vessels to the right of the mid-line due to atrophy of this hemisphere.

B. Pneumoencephalogram of the same patient, which confirms the right cerebral hemiatrophy. The ventricles are shifted to the right, the right ventricle is enlarged, and there is an increased amount of air in the subarachnoid space. Same case as Fig. 1.

ical cases). Intracranial calcification detectable on the skull roentgenogram was present in only 3 of the 15 cases, in patients aged seven, nine, and twelve years, respectively, at the time of the initial examination. The results of angiographic study are summarized in Table I.

Cerebral angiography was reported as completely negative in 3 instances. In 4 other cases there was no demonstrable vascular abnormality but cerebral atrophy was shown by arteriography. Vascular abnormalities of some type were found in 8 of the 15 patients (53.3 per cent). In only 1 of the 3 cases with intracranial calcification was the cerebral angiogram positive. It is noteworthy that in 3 instances more than one type of vascular abnormality was present, and that in 2 cases vascular thrombosis and cerebral atrophy could be demonstrated angiographically in the same patient.

Fig. 5. Probable thrombosis or agenesis of the superior longitudinal sinus (arrow). No suggestion of any filling of the sinus anterior to this point could be seen. The lateral sinus (3 arrows) filled without filling of the torcular Herophili and of the transverse sinus. Same case as Fig. 3. Film made at five seconds.

CASES FROM THE LITERATURE

The age of the patient at the time of cerebral angiography was mentioned in 31 of the 35 cases from the literature, ranging from eighteen months to sixty-four years. Presence or absence of calcification visible on skull roentgenograms was mentioned in 32 of the number. Twenty-five cases could be classified as typical Sturge-Weber

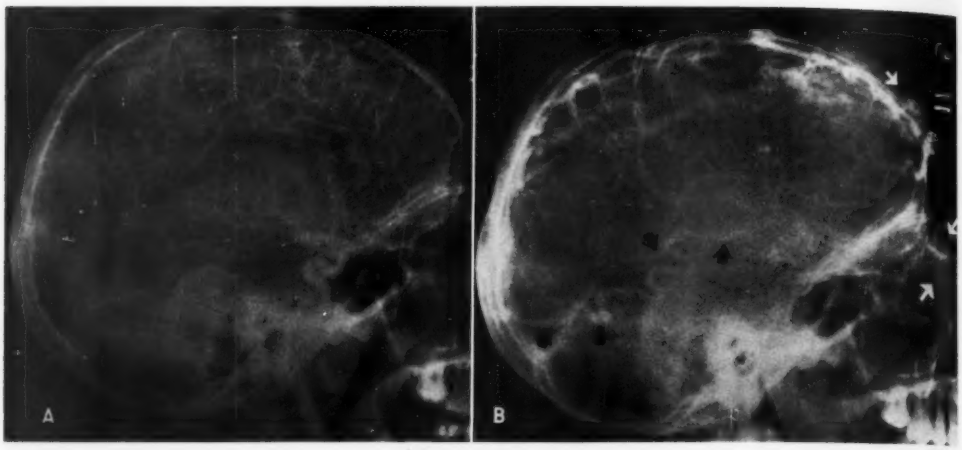


Fig. 6. A. Film made during the arterial phase of a right carotid angiogram in an eighteen-year-old boy with facial nevi and other stigmata of Sturge-Weber's syndrome. Only the internal carotid artery filled (arrow).
B. Film made during the venous phase shows filling of the nevi over the forehead and nose (white arrows), evidently by way of the internal carotid artery. Also note unusual appearance of venous channels (black arrows).

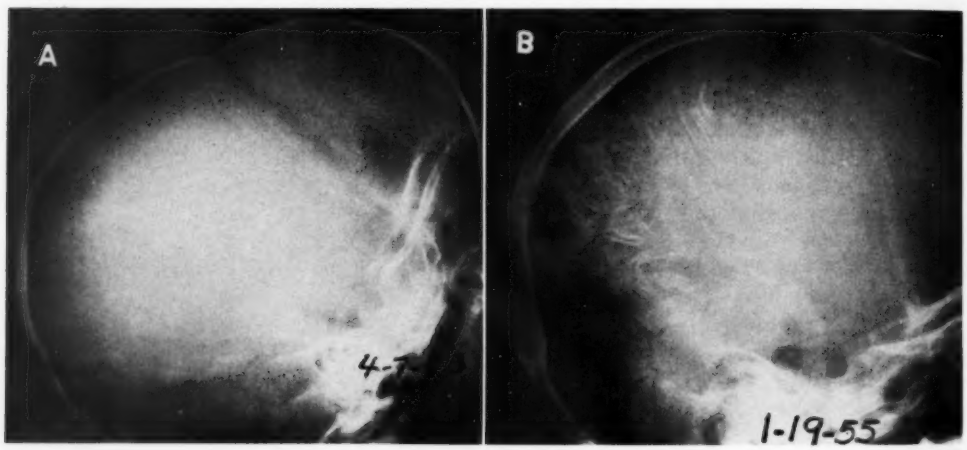


Fig. 7. A. Normal skull of a twelve-month-old child.
B. Film showing massive calcification in the parietal and occipital areas twenty-one months later.

disease. In 4 instances no details were given, but we have considered them of Type I because they were referred to as Sturge-Weber syndrome by the reporting authors. There were 6 examples of Type II and 4 of Type III. Details of the angiographic examination are summarized in Table II. Positive cerebral angiograms were recorded in 15 of the 35 cases (42.8 per cent). In many instances published case reports did not include adequate reproductions of the arteriograms, and the authors' descriptions were accepted as given.

COMBINED SERIES

For the purpose of further analysis, our cases have been combined with those collected from the literature, making a total of 50 in which cerebral angiography was performed.

Twenty-three positive angiograms were obtained in the 50 cases (46 per cent). The findings were positive in 15 of the

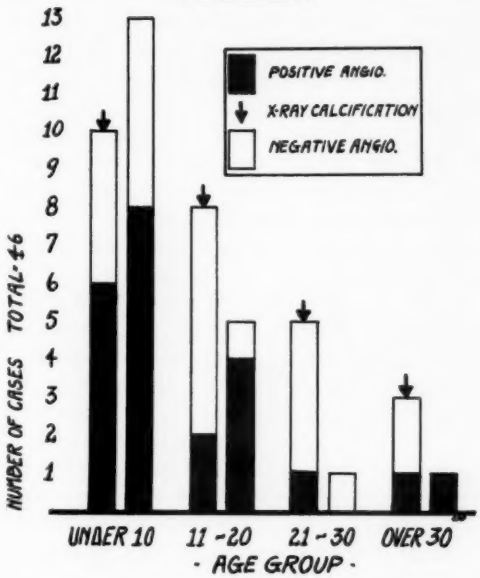
34 typical (clinical Type I) cases (44 per cent) and in 4 each (50 per cent) of the 8 cases of the incomplete form (Type II) and of the atypical form (Type III).

The average age of the patients with abnormalities demonstrable angiographically was 10.8 years, while for those with normal angiograms it was 15.2 years. A comparison of the results of cerebral angiography for the first three decades of life showed 59 per cent positive in the first decade, 50 per cent in the second, and only 29 per cent in the third.

The relationship between intracranial calcification and the results of cerebral angiography were further investigated. Calcification was present in 27 of the 47 cases in which information on this point was available (57.5 per cent). It occurred in 18 of the 34 typical (Type I) cases (53 per cent). The youngest patient with intracranial calcification was eighteen months old.

Cerebral angiography was positive in 10 of the 27 cases (37 per cent) with calcification and in 13 of the 23 (65 per cent) in which no calcification was visible. The relationship between the age of the patient at the time of cerebral angiography, the results of angiography, and the presence or absence of visible intracranial calcification, is shown in Table III.

TABLE III: INCIDENCE OF POSITIVE FINDINGS IN CEREBRAL ANGIOGRAPHY WITH RELATION TO INTRACRANIAL CALCIFICATION AND AGE OF PATIENT AT TIME OF EXAMINATION



It has long been believed that the venous angioma is the characteristic vascular anomaly in this syndrome. It is interesting to note (Tables I and II) that in only 8 of the 34 typical cases (24 per cent), 3 of the 8 incomplete cases (38 per cent), and 1 of the 8 atypical cases (12.5 per cent) were venous angiomas found. The typical venous angioma was thus demonstrated by cerebral angiography in only 12 of the 50 cases, 24 per cent, as compared to 46 per cent if all types of angiographic abnormalities are considered.

DISCUSSION

It becomes apparent from the results of this investigation that the angiographic findings in encephalo-trigeminal angiomatosis are not exclusively of the venous angioma or telangiectasis type referred to as characteristic by Bergstrand, Olivecrona and Tönnis. This type of vascular anomaly was, however, encountered most often. The venous or capillary angiomas were most frequently located in the posterior parietal regions. In one patient (Fe) who had bilateral facial nevi, the intracranial vascular abnormalitiy was also bilateral. This type of vascular anomaly is more frequently observed in the typical cases of Sturge-Weber disease, but may also be found in what we have called "atypical" forms. In our own series, we found no instance of a true arteriovenous anomaly, but Laur's 15-year-old patient with a typical facial nevus, convulsions, and eye involvement had a huge arteriovenous angioma occupying most of the contralateral hemisphere. The contralateral location is surprising, although Peters, in 1937, reported a case of Sturge-Weber syndrome with a *left*-sided facial nevus and typical calcification in the *right* cerebral hemisphere.

In none of the cases in our own group nor in any collected from the literature

were there episodes of subarachnoid hemorrhage such as were noted by Cushing in 1906. Several of our patients did have an elevation of the protein content of the cerebrospinal fluid.

The patients in whom arteriographic Group III anomalies (arterial thromboses) were encountered are of peculiar interest in relation to this syndrome where hemiparesis with or without hemiatrophy is so frequently encountered. In one of our cases (Fe) there was thrombosis of one of the major branches of the middle cerebral artery (Fig. 4). In our other Group III case (Da), there was either thrombosis of arterioles and capillaries, producing relative avascularity in the territory of the posterior cerebral artery, or numerous dilated capillaries producing diffuse increase in density on the opposite side (Fig. 2). Both posterior cerebral arteries were filled simultaneously through the vertebral artery. Furtado and Rodrigues found thrombosis of the posterior cerebral artery in their cases, while Hunt and Moore described absence of vascularization in the territory of a branch of the middle cerebral artery.

The thrombosis of a major branch of the middle cerebral artery in our patient (Fe) is especially noteworthy, since such a finding is rarely demonstrable in cases of so-called acute infantile hemiplegia. We have performed cerebral angiography in 12 children with this syndrome and were able to demonstrate thrombosis in only 3 instances. In children with encephalotrigeminal angiomatosis, hemiplegia not infrequently develops suddenly, in a manner suggesting a vascular accident.

Abnormalities of veins and dural sinuses in this series suggest that these anomalous vessels may have been draining vascular anomalies which thrombosed or could not be demonstrated angiographically. In one of our cases (Ro), in addition to a capillary-venous angioma in the occipital region, there was suspected thrombosis (or agenesis) of the anterior part of the superior longitudinal sinus. In another case (Bi) there was a capillary-venous angioma occupying a large portion of the hemisphere, with unusually wide venous channels draining it. Olivecrona and Engelhardt both described abnormally large veins coursing in unusual directions.

Anomalies in the course of the external carotid artery were found in only 3 cases in the series. This is perhaps fewer than might be expected. Filling of the external carotid artery was ordinarily obtained in our cases because the injection was made into the common carotid artery. In 1 case (Om) the extracranial angioma filled from the external carotid circulation, while in another (Re) the external angioma filled *via* the internal carotid artery through the calvarium (Fig. 6), a situation analogous to that in the case reported by Sunder-Plassman.

In the last arteriographic group we have placed our own 6 cases in which cortical atrophy was demonstrated by angiography, and that of Torkildsen and Koppang with a subdural hematoma. The latter may presumably have originated from rupture of a small angioma, but no clinical information is available about this case. Cortical atrophy is a frequent finding in encephalotrigeminal angiomatosis. It may be accompanied by cranial asymmetry or the fully developed Dyke-Davidoff-Masson syndrome (cerebral hemiatrophy with cranial hemihypertrophy) and contralateral hemiparesis and hemiatrophy. In 6 of our 15 patients cerebral atrophy was shown arteriographically. Four more were shown by pneumoencephalography to have some degree of cortical atrophy, but not enough to be demonstrated angiographically.

The age of the patient at the time of cerebral angiography seems to have some relationship to the incidence of abnormal angiographic findings. The most striking abnormalities were found chiefly in younger patients. This is somewhat more apparent in our small group of 15 cases.

The relationship between the presence of intracranial calcification and the results of cerebral angiography bears further discussion. Cerebral angiography gives a high percentage of positive results in those

cases in which there is no calcification visible on skull roentgenograms. That an angiomatous malformation can exist at the same time with intracranial calcification is well demonstrated in the cases reported by Furtado, Green, Sugar and Curtis. It will be noted that in all of these the angioma and the calcification were in close proximity.

In our own group, we had the opportunity of watching the development of cortical calcification in 2 patients. One (Fe) had a negative x-ray examination of the skull at the age of five and a half months, at which time cerebral angiography demonstrated bilateral capillary-venous angiomas. Fifteen months later, on re-examination of the skull, there was a rather massive bilateral Weber-type calcification in the general area of the angiomas (Fig. 1, C and D). The second patient (Sc) also had a negative skull film and arteriographic demonstration of an angioma at the age of twelve months. When films of the skull were obtained at the age of thirty-three months, there was massive calcification in the general area of the angioma (Fig. 7, A and B). In a third patient (Da), who had negative skull films and an area of avascularity at the age of three and a half years, skull films taken subsequently failed to demonstrate intracranial calcification, but autopsy performed seven months later revealed microscopic calcification in the area found to be avascular. Unfortunately, we have been unable to repeat angiographic examination in any of our cases.

SUMMARY AND CONCLUSIONS

Cerebral angiography was performed on 15 patients with encephalo-trigeminal angiomatosis. An additional 35 cases of this syndrome which had been investigated by the same procedure were collected from the literature.

Cerebral angiography revealed an abnormality of the cerebral vascular system in 23 of the 50 cases (46 per cent). In addition to the classical capillary-venous angioma usually described pathologically in this syndrome, arteriovenous malformations, arterial thromboses, anomalies of veins and dural sinuses, and anomalies in the territory of the external carotid circulation were demonstrated. Subdural hematoma and cerebral atrophy or hypoplasia were shown arteriographically in some cases.

Intracranial calcification was visible on x-ray examination of the skull in 27 of 47 cases. Cerebral angiography was positive in 10 of the 27 cases with calcification (37 per cent) and in 13 of the 20 cases without calcification (65 per cent). The average age of the patients with positive angiograms was lower in both the group with and without calcification. It was found that increasing age and the presence of intracranial calcification decreased the chances of demonstrating vascular abnormalities by cerebral angiography.

Follow-up studies on 2 cases illustrated the rapid development of massive Weber-type calcification in patients with previously demonstrated capillary-venous angioma.

From this study the conclusion is drawn that, if an intracranial angioma can be shown, rapid and massive cortical calcification will probably develop.

NOTE: The authors express their thanks to Dr. H. Houston Merritt for his helpful criticism and advice.

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BIBLIOGRAPHY

BERGSTRAND, H., OLIVECRONA, H., AND TÖNNIS, W.: Gefässmissbildungen und Gefässgeschwülste des Gehirns. Leipzig, Georg Thieme, 1936.

CONTINI, M., AND LEONI, G.: Neuroangiomatosi encefalofaciale. Rass. studi psichiat. **41:** 367–387, May–June 1952.

CRAIG, J. M.: Encephalo-trigeminal Angiomatosis (Sturge-Weber's Disease). Case Report. J. Neuropath. & Exper. Neurol. **8:** 305–318, July 1949.

CURTIS, J. B.: Rapid Serial Angiography. J. Neurol., Neurosurg. & Psychiat. **12:** 167–182, August 1949.

CUSHING, H.: Cases of Spontaneous Intracranial Hemorrhage Associated with Trigeminal Naevi. J.A.M.A. **47:** 178, 1906.

DICHIRO, G., AND LINDGREN, E.: Radiographic Findings in 14 Cases of Sturge-Weber Syndrome. Acta radiol. **35:** 387–399, May–June 1951.

ECKEL, K.: Zur Stellung der Sturge-Weberschen Krankheit im Rahmen der kongenitalen Ektodermosen. Wien. Ztschr. Nervenh. **3:** 184–195, 1950.

ENGELHARDT, H.: Zur Kenntnis der Sturge-Weberschen Krankheit. Psychiat.-neurol. Wchnschr. **44**: 313–315, Oct. 3, 1942.

ENGESET, A.: Cerebral Angiography with Perabrodil. Acta radiol. Suppl. 56, 1944.

FURTADO, D.: Maladie de Krabbe. Rev. neurol. **65**: 640, 1936.

FURTADO, D., AND RODRIGUES, M.: Pathogénie de la maladie de Sturge-Weber-Krabbe. Ann. méd. psychol. **105**: 398, 1947.

GREEN, J. R.: Encephalo-trigeminal Angiomatosis. J. Neuropath. & Exper. Neurol. **4**: 27–42, January 1945.

HEBOLD-KOCH: Cited by Myle (1950).

HUNT, H. B., AND MOORE, R. C.: Encephalo-trigeminal angiomatosis. M. Radiog. & Photog. **27**: 53–60, 1951.

LAMY, M., AUSSANNAIRE, M., JAMMET, M. L., AND GANO, M.: L'angiomatose faciale, rétinienne et encéphalique. Arch. franç. pédiat. **6**: 302, 1949.

LAUR, A.: Cerebrales Riesenangiom mit Anomalie der grossen Arterien und multiplen sackförmigen Aneurysmen. Deutsches Arch. klin. Med. **200**: 236–249, 1953.

MONIZ, EGAS: Diagnostic des tumeurs cérébrales et épreuve de l'encéphalographie artérielle. Paris, Masson & Cie, 1931.

MONIZ, EGAS, AND ALMEIDA LIMA: Pseudo-angiomes calcifiés du cerveau. Angiome de la face et calcifications corticales du cerveau (maladie de Knud H. Krabbe). Rev. neurol. **63**: 743–750, May 1935.

MYLE, G.: Sémiologie de l'angiomatose encéphalo-trigéminée ou encéphalo-crânio-faciale. Acta neurol. et psychiat. belg. **50**: 713–786, December 1950.

NICOLATO, A.: Angioma retinico ed angioma cerebrale. Ann. oftal. **61**: 736, 1933.

NORTHFIELD, D.: Angiomatous Malformations of the Brain. Guy's Hosp. Rep. **90**: 149, 1940.

OLIVECRONA, H.: In Bergstrand, Olivecrona and Tönnis, 1936. Chapter 2.

PETERS, G., AND TEBELIS, F.: Beitrag zur Klinik, Anatomie und Pathogenese der Sturge-Weberschen Krankheit. Ztschr. f. d. ges. Neurol. u. Psychiat. **157**: 782–794, 1937.

PICAZA, J. A.: Cerebral Angiography in Children. Anatomoclinical Evaluation. J. Neurosurg. **9**: 235–244, May 1952.

POSER, C. M., AND TAVERAS, J. M.: Clinical Aspects of Cerebral Angiography in Children. Pediatrics **16**: 73–80, July, 1955.

RIECHERT, T.: Die Arteriographie der Hirngefässe. Munich-Berlin, Lehmann, 1943.

STURGE, W.: A Case of Partial Epilepsy Apparently Due to One of the Vasomotor Centers of the Brain. Clin. Soc. London Tr. **12**: 162, 1879.

SUGAR, O.: Pathological Anatomy and Angiography of Intracranial Vascular Anomalies. J. Neurosurg. **8**: 3–22, January 1951.

SUNDER-PLASSMAN, P.: Morbus Sturge-Weber. In Durchblutungsschäden und ihre Behandlung. Neue Deutsche Chirurgie, Band 65, Stuttgart, Enke, 1943.

TAVERAS, J. M., AND POSER, C. M.: Radiologic Aspects of Cerebral Angiography in Children. To be published.

TORKILDSEN, K., AND KOPPANG, K.: Percutaneous Carotid Angiography. J. Brasil. Neurol. **2**: 65, 1950.

ZWEYMÜLLER, E.: Das Krankheitsbild von Sturge-Weber. Osterr. Ztschr. Kinderh. **7**: 35, 1952.

SUMMARIO IN INTERLINGUA

Angiographia Cerebral in Angiomatosis Encephalo-Trigeminal

Angiographia cerebral esseva executate in 15 patientes con angiomatosis encephalo-trigeminal. Un total de 35 altere casos de iste syndrome investigate per le mesme methodo esseva colligite in le litteratura.

Angiographia cerebral revelava un anormalitate del systema cerebro-vascular in 23 del 50 casos (46 pro cento). A parte le classic angioma capillari-venose que es usualmente describite pathologicamente in iste syndrome, malformationes arteriovenose, thromboses arterial, anomalias de venas e sinuses dural, e anomalias in le territorio del circulation carotide externe esseva demonstrate. Hematoma subdural e atrophia o hypoplasia cerebral esseva demonstrate arteriographicamente in un certe numero de casos.

Calcification intracranial esseva visibile in le examine roentgenologic del cranio in 27 ex 47 casos. Angiographia cerebral esseva positive in 10 ex 27 casos con calcification (37 pro cento) e in 13 ex 20 casos sin calcification (65 pro cento). Le etate medie del patientes con angiogrammas positive esseva plus basse in ambe gruppos, illo con e illo sin calcification. Esseva constatate que augmento de etate e presentia de calcification intracranial reduce le prospectos de successo in le effortio de demonstrar anormalitates vascular per angiographia cerebral.

Studios de consecution in 2 casos illustrava le rapide disveloppamento de calcificationes massive del typo Weber in patientes con previemente demonstrate angioma capillari-venose.

Ab iste studio le conclusion es derivate que in casos in que le presentia de angioma intracranial pote esser demonstrate il es probabile que un rapide e massive calcification cortical va disveloppar se.

The Obstructed Ureteropelvic Junction[1]

ROBERT LICH, Jr., M.D.[2]

IT IS SELDOM realized that at least 90 per cent of major urologic problems are related to urinary tract obstruction, dysfunction, and infection. The importance of this is reflected in the vigorous campaign, waged by urologists for years, to salvage functionally impaired renal tissue. Today, "renal salvage" is becoming increasingly important as the incidence of trauma mounts. To save even a third of a kidney may be to save the tissue which preserves life in a future accident in which the opposite kidney is destroyed either temporarily or permanently.

The most common site for supravesical congenital obstruction of the urinary tract is the ureteropelvic junction. Interest in determining the cause of such obstruction was stimulated in the course of an effort to establish a consistently successful corrective surgical procedure. This study will present a heretofore unrecognized cause of obstruction, with a description of an operation that has been unusually successful in re-establishing a morphologically and physiologically normal ureteropelvic area.

Obstructions of the ureteropelvic junction are not uncommon, but they vary greatly in degree. In a review of 250 consecutive retrograde pyelograms, some evidence of pyelectasis, unilateral or bilateral, was found in 76.2 per cent, though in not a single instance was this clinically significant. Our interest lies in those cases in which the obstruction is sufficient to cause not only pyelectasis, but also calyceal blunting and retention of urine beyond the usually acceptable ten-minute interval. The two problems studied were: (*a*) the cause of obstruction and (*b*) its surgical correction.

Henline and Menning pointed out, some years ago, that the prevalent concept of roentgenologists and urologists alike was that ureteropelvic obstruction was due to an extrinsic cause, *i.e.*, aberrant vessels, fibrous bands, etc. Actually, these abnormalities are only rarely responsible. In Henline's own experience, less than 50 per cent of the patients treated by division of these seemingly obstructive structures had satisfactory renal drainage postoperatively, and the incidence of secondary nephrectomy for progressive hydronephrosis was at least 60 per cent. Such reports in the literature, in addition to our own observations, led to the initiation of this study almost twenty years ago.

In view of repeated instances in which the resection of an apparently obstructing band or vessel was valueless in relieving ureteropelvic obstruction, it was quite apparent that the cause of obstruction must be sought elsewhere. Furthermore, if one attempted to reconstruct the picture with the renal pelvis in its initial non-dilated state, the location of the obstructing band or vessel would seemingly be sufficiently far removed to be of no obstructive significance. After the pelvis dilated, however, attendant alteration of the location of the ureteropelvic junction could easily place it in an obstructive relationship to these nearby vessels or bands. The same situation can be visualized with reference to a high pelvic insertion of the ureter. In other words, as the renal pelvis enlarges, the ureteropelvic junction is elevated until its usual dependent position is lost and the picture of high insertion with apparent kinking results. It was thought too, by some workers, that a constant pulsation of the vessel against the ureter might transform the normal ureteral musculature into fibrous tissue, resulting in an

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[1] Presented at the Forty-second Annual Meeting of the Radiological Society of North America, Chicago, Ill. Dec. 2–7, 1956.

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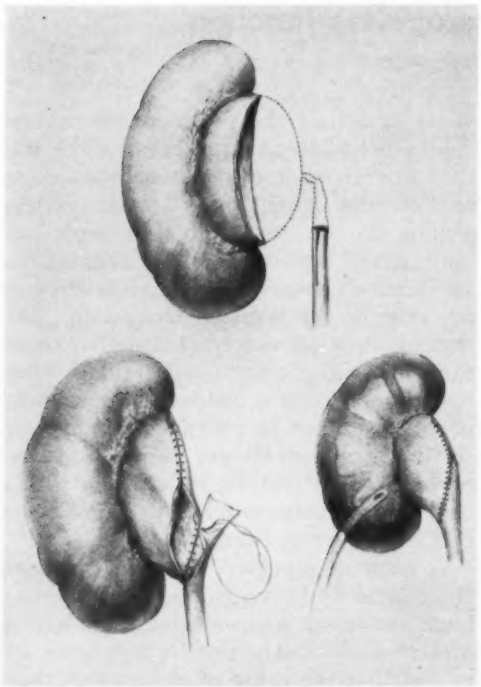

Fig. 1. Method of pyeloplasty.

intrinsic as well as an extrinsic obstruction. It was with this background that this investigation was undertaken. Owing to such factors as relatively infrequent clinical material, unavoidable interruption, and the pursuance of false leads, a number of years were required to arrive at our present conclusions, based upon unmistakable histologic and clinical evidence and proved by successful corrective surgery.

Our first interest was in the intrinsic structure of the abnormal ureteropelvic junction. An excess of fibrous tissue was found in some specimens. Absence of infection suggested that this fibrous tissue was not of inflammatory origin. It appeared rather to represent a replacement of muscular development, with associated ureteral dysfunction. Observation of additional specimens, however, revealed an inconsistency in this finding, so that fibrosis as a common etiological agent was discarded. Specimens were also studied for an excess of elastic tissue, collagen, and muscular hyperplasia, but again, inconsistent findings ruled out each of these several possibilities. The complexity of the task is appreciated further when it is realized that not only are these cases relatively infrequent, even in a large teaching hospital, but that excision of the ureteropelvic junction with ureteropelvic anastomosis was considered urologic surgical heresy. Hence, we were obliged to perfect a surgical procedure for repair of the ureteropelvic defect which would afford the possibility of histologic study of this anatomic area.

Fig. 2. Longitudinal section of normal ureter.

The method of surgical repair of the obstructed ureteropelvic junction was based on the premise that the retention of abnormal tissue in a corrective procedure is basically illogical. The operation is depicted in Figure 1. Essentially, it embodies the excision of the ureteropelvic junction along with the redundant renal pelvis. A new ureteropelvic junction is created by an anastomosis of the split ureter to the lower portion of the resected renal pelvis and closure of the remaining pelvis. The newly constructed ureteropelvic junction is composed partially of ureter and pelvis, with an adequate lumen, and its construction is accomplished with technical ease. The suture material is extremely small caliber (4 or 5 0 chromic) catgut, affording a minimum of suture

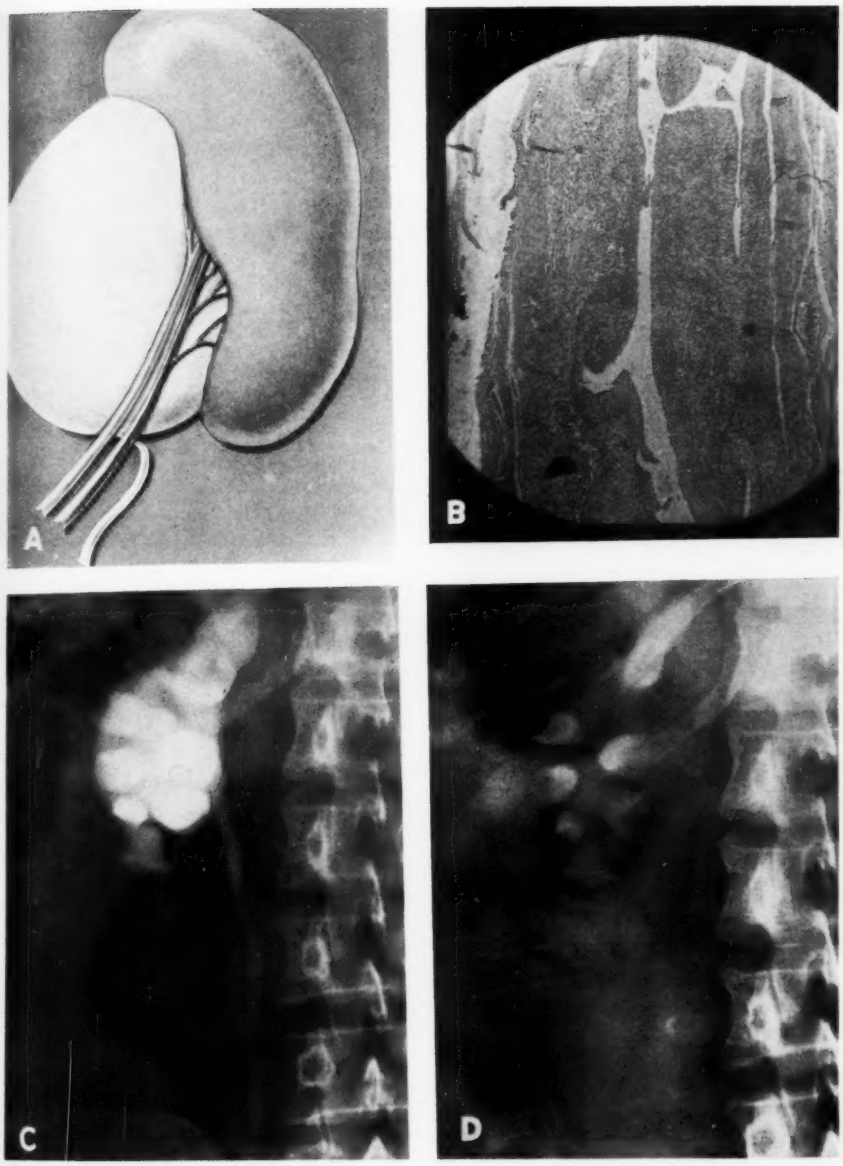

Fig. 3. Case I: A 44-year-old married woman with a ten-year history of recurrent pyelonephritis. The posterior view of the kidney (A) shows the vessels to be of no obstructive significance. The renal vessels indent the pyelectatic renal pelvis, but there is no evidence of ureteral compression. The photomicrograph of the ureteropelvic junction (B) demonstrates the large valve-like structure (the tip of which was broken in slide preparation) pointing upward toward the renal pelvis. On the opposite side near the top of the photomicrograph the base of another valve can be seen. The marked inflammatory infiltration is due to this patient's prolonged recurrent renal infection.

The first film (C), made preoperatively, shows a congenital renal rotation with hydronephrosis. The second film (D) was taken five years following surgery, during which period there had been no recurrence of urinary infection.

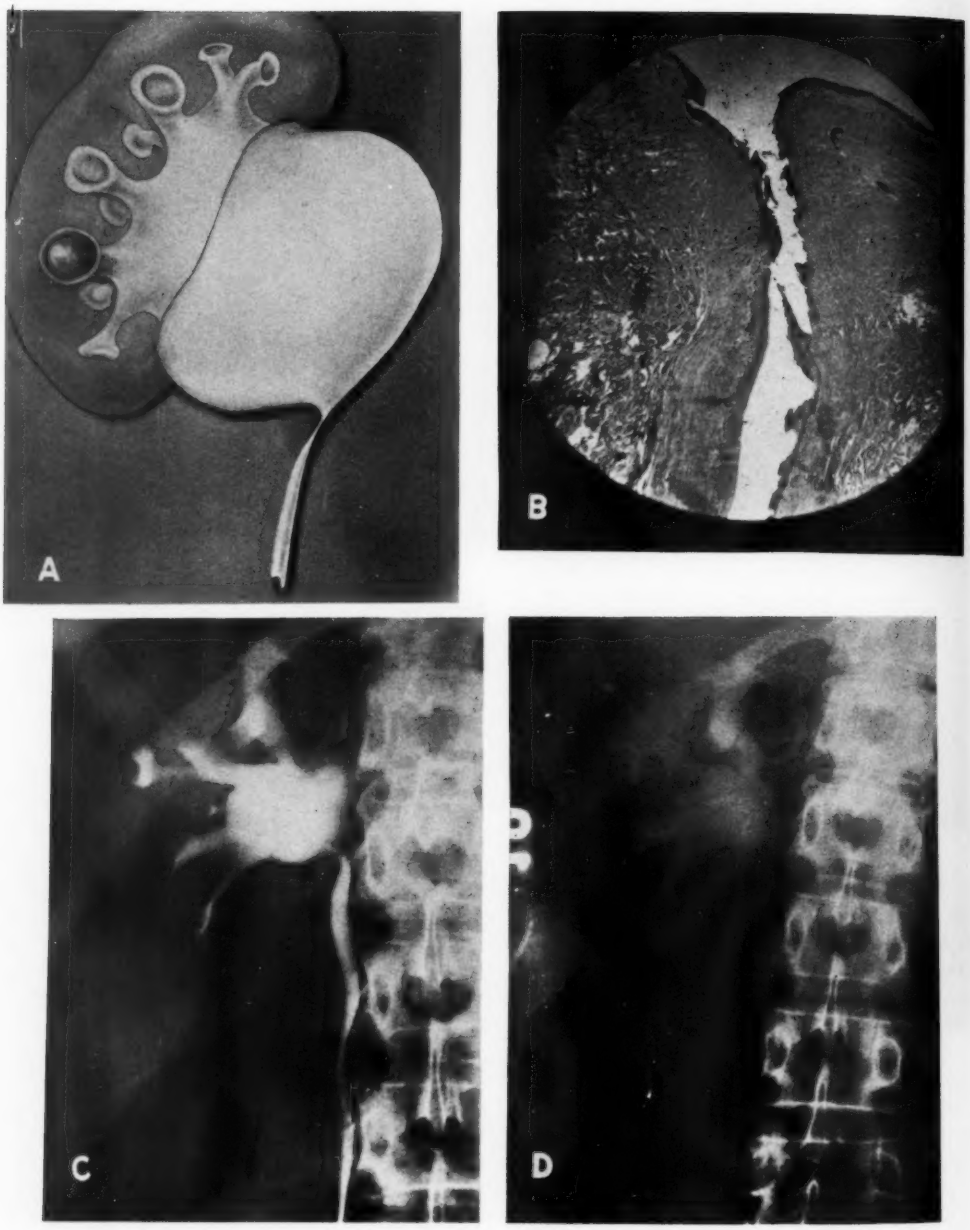

Fig. 4. Case II: A 47-year-old housewife with right pyelonephritis and nephrolithiasis (A). The ureteropelvic obstruction, found on urography, occasioned the resection of the ureteropelvic junction at the time of pyelolithotomy. The photomicrograph of the ureteropelvic area (B) demonstrates a singular small valvular structure which was distinct in a review of many sections. Here, however, epithelial hyperplasia, with marked connective tissue proliferation, was the primary cause of obstruction. The pyelograms show the preoperative appearance (C) and the normal kidney (D) one year following surgery.

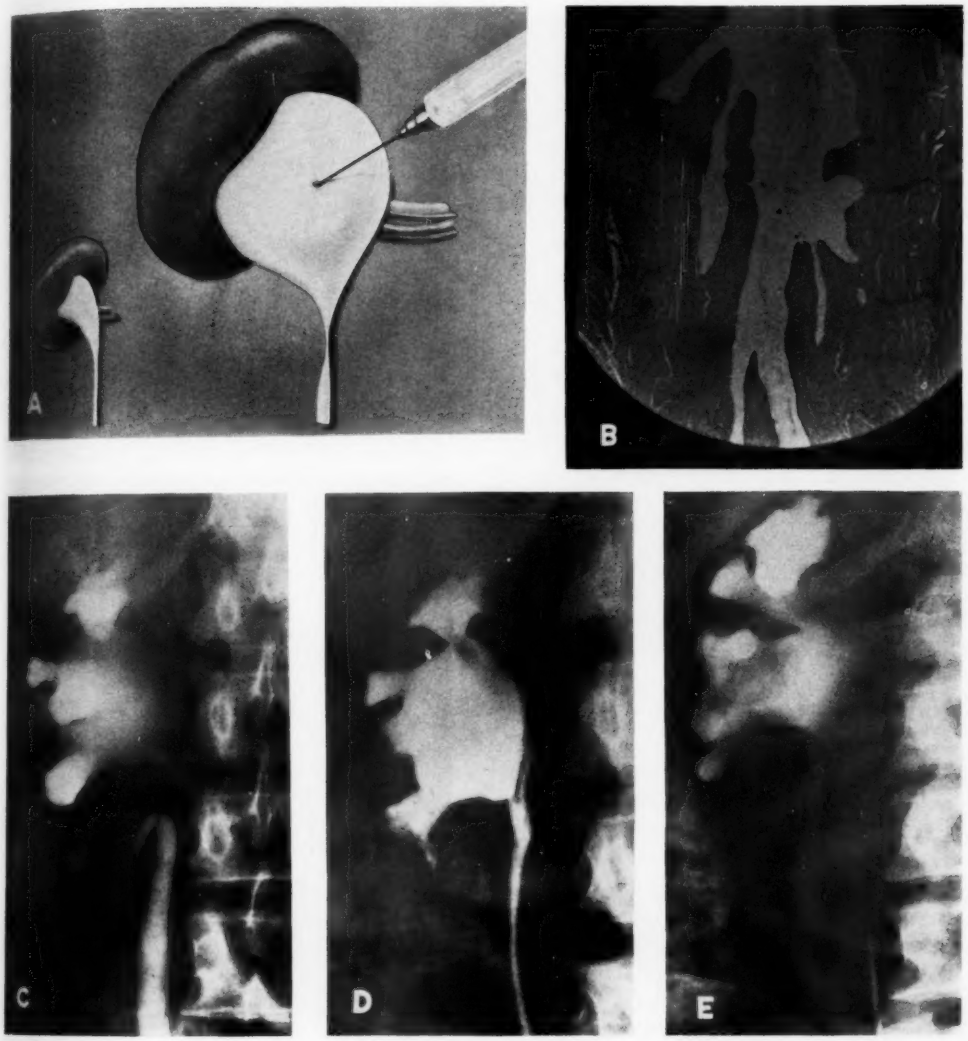

Fig 5 Case III: A 27-year-old housewife with right pyelonephritis and hydronephrosis. The ureteropelvic obstruction was evident in the urogram (C), but the cause of the hydroureter was unexplained and disappeared postoperatively, as apparent in the films taken two weeks (D) following surgery and two months (E) after pyeloplasty.

At surgery it was somewhat disconcerting to find a normal kidney with no evidence of pyelectasis, as shown in the small insert in A. When the renal pelvis was injected with saline, however, a most prominent ureteropelvic obstruction appeared, with marked pyelectasis which would not drain down the ureter even with manual pressure on the pelvis. The multiple valve-like formations in the photomicrograph (B) are evident.

reaction. A nephrostomy tube minimizes intrapelvic pressure during healing.

In association with Dr. Malcolm L. Barnes,[3] studies of the abnormal ureteropelvic junction were continued, and it was decided to investigate longitudinal sections of this area rather than the conventional cross sections. With this change in technic a consistent abnormality was found, which varied only in degree. In most instances of obstructed ureteropelvic junc-

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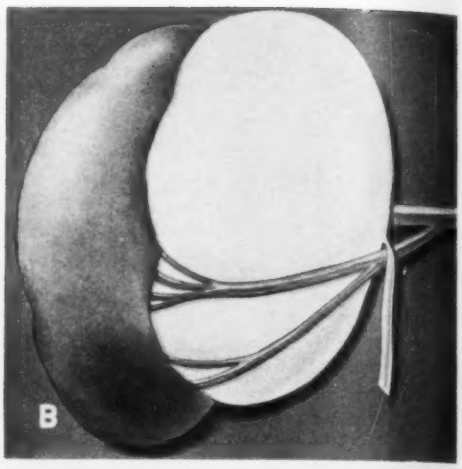

Fig. 6. Case IV: A 20-year-old girl with an infected functionless right pyelectasis. The aberrant vessel seemingly obstructs the ureteropelvic junction (A). The photomicrograph (C), however, demonstrates striking valves, which most graphically bear witness to the factor of intrinsic obstruction. The marked submucosal cellular infiltration and edema are the result of profound pyelonephritis.

tion there appeared valve-like structures that were always directed toward the renal pelvis, acting as an obstruction to the free flow of urine from the pelvis through the ureter, but seldom interfering with the retrograde passage of a ureteral catheter. Furthermore, the histologic delicacy of these valves explains why antegrade instrumental calibration of the junction during surgery is not necessarily a measure of functional capacity.

After observation of a considerable number of these patients, the normal ureteropelvic junction was similarly studied and found to be free of valvular areas. Furthermore, in cases of moderate pyelectasis encountered at autopsy, valvular obstructions of varying degree were observed in the ureteropelvic junction. Figures 3–7 show instances of pyelectasis, the obstructing valvular mechanism, and, in 4 cases, the eventual surgical result. It may be concluded, then, that in most instances of pyelectasis the mechanism is a congenital intrinsic valvular obstruction of the ureteropelvic junction and that aberrant vessels or fibrous bands rarely play more than a contributory role.

There is one phase of successful pyeloplasty wherein we must depend upon the radiologist for assistance. We have observed that not all instances of repair function with equal efficiency early in the post-

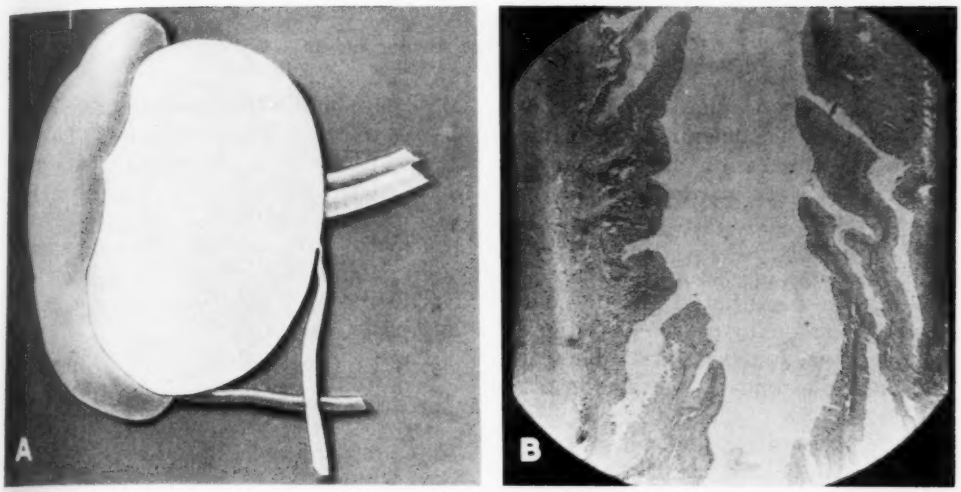

Fig. 7. Case V: A 57-year-old male with a non-infected pyelectasis. The pyelogram was identical with that shown in Fig. 6. At surgery, a high insertion of the ureter was encountered (A) and the aberrant vessel was found to be of no obstructive importance. The photomicrograph (B) shows a multiplicity of ureteral valves projecting toward the renal pelvis with minimal inflammatory reaction and submucosal edema.

operative period. It is not beyond the realm of possibility that this is because the newly formed anastomosis is accomplished in a portion of the ureter where the peristaltic wave is not optimally active or, indeed, is even antagonistic to our efforts. It would seem, too, in observing films taken during excretory pyelography, as well as serial films of ureteral emptying, that the ureteral wave proceeds in a distinct pattern. To know precisely at what point to divide the ureter below its junction with the pelvis may be the key to a more consistent early functional result. It might eliminate the need for the nephrostomy tube to keep the intrapelvic pressure at a minimum until efficient ureteral peristalsis is established. This matter of reno-ureteral transport requires study, and cinefluorography would presumably contribute definitely to its clarification. The radiologist has much to offer the urologist in the solution of several current problems of urinary tract mechanics and physiology.

SUMMARY

Evidence is presented that ureteropelvic obstruction is due most often to intrinsic ureteral pathology in the form of valvular structures which impede the flow of urine down the ureter. A simple time-tested method of pyeloplasty is briefly discussed and several illustrative cases are included.

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REFERENCES

HENLINE, R. B., AND MENNING, J. H.: The Management of Hydronephrosis Due to Ureteropelvic Obstruction: Preliminary Report. J. Urol. **50**: 1–24, July 1943.

LICH, R., JR., AND MAURER, J. E.: Congenital Hydronephrosis. J.A.M.A. **157**: 577–579, Feb. 12, 1955.

LICH, R., JR., MAURER, J. E., AND BARNES, M. L.: Pyelectasis. J. Urol. **75**: 12–16, January 1956.

LICH, R., JR., AND BARNES, M. L.: A Clinico-Pathologic Study of Ureteropelvic Obstructions. J. Urol. In press.

(*Por el summario in interlingua, vider le pagina sequente*)

SUMMARIO IN INTERLINGUA

Obstruite Junction Ureteropelvic

Super le base de quasi vinti annos de studio le autor documenta le these que le majoritate del casos de obstruction ureteropelvic pote esser attribuite a congenite intrinsec structuras valvular que impedi le fluxo de urina in le ureter. Vasos aberrante o bandas fibrose ha rarmente plus que un rolo contributori. Es describite un simple methodo de pyeloplastia. In illo un nove junction ureteropelvic es create per anastomose ab le findite ureter al portion inferior del resecate pelve renal. Le resto del pelve es claudite. Le servicios del radiologo es specialmente utile in le determination del plus favorabile sito pro le anastomose. Le problema de transporto reno-ureteral require studios additional. Es formulate le opinion que cinefluoroscopia pote contribuer a un solution de ille problema.

Plure casos illustrative es includite in le reporto.

Ureteritis Cystica and Pyelitis Cystica

A Review of Cases and Roentgenologic Criteria[1]

BERNARD S. LOITMAN, M.D., and HAROLD CHIAT, M.D.

PYELO-URETERITIS cystica is a benign and usually asymptomatic disease of the upper urinary tract. Pathologically it consists of small subepithelial cysts which elevate the mucous membrane of the renal pelvis and ureter and appear as round radiolucent areas on urographic studies. Very little has been written about pyelo-ureteritis cystica in the radiologic and urologic literature, where it should receive the greatest attention (1). Since it is quite possible that many physicians have never seen this condition, it may present a differential problem when it does occur.

It is our purpose in this paper to discuss the pathology and radiographic characteristics of ureteritis and pyelitis cystica and to review our experience with this disease. Cystitis cystica will also be given some consideration, since it is similar histologically. This condition, however, is almost always diagnosed by cystoscopy and is rarely recognized on the urogram.

HISTOLOGY

The upper urinary tract, including the renal pelves, ureters, and bladder, is of similar histologic structure, being composed essentially of three layers. The inner layer of mucous membrane is connected directly to the middle smooth muscle layer by lamina propria. There is no distinct submucosa in man. The outer layer is a coat of connective tissue, the adventitia. The mucosal lining is a transitional epithelium which increases in cell thickness as it approaches the bladder (2).

The pathogenesis of pyelo-ureteritis cystica and cystitis cystica is the same, both conditions arising from cystic degeneration of epithelial cell nests (3). The cysts are situated immediately beneath the mucosal lining and elevate it into the lumen (Figs. 1 and 3). In the renal pelvis and ureter the cysts range from microscopic dimensions to as much as 2 cm. in diameter; in the bladder they measure up to 3 cm. (4).

In 1,590 routine autopsies reported by Pessin (4), the incidence of ureteritis cystica was 0.05 per cent. Cystitis cystica is a much more common finding.

HISTORY AND PATHOGENESIS

Pyelo-ureteritis cystica was recognized long ago, being first described in 1761 by Morgagni (5), who reported 2 cases. Rayer (6) in 1837, Virchow (7) in 1863, and Rokitansky (8) in 1861 published additional case reports. Litten (9) in 1876, von Limbeck (10) in 1887, and von Brunn (3) in 1893 made the first detailed microscopic examinations in autopsied cases.

Over the years several theories have been offered to explain the etiology and pathogenesis of this disease. In 1889 Eve (11) reported a case which he attributed to a parasite. Urquhart (12), more recently, found *Schistosoma haematobium* in 6 cases of cystitis cystica seen at autopsy. Litten (9) and Virchow (7) suggested inflammatory blockage of glands and crypts in the mucous membrane as the source of the cysts. Von Brunn (3), however, was unable to find true glands in calyces, pelves, or ureters, to support this theory. He explained the cyst formation on the basis of degeneration of central cells in epithelial nests lying beneath the mucous membrane. These nests, he believed, develop as buds from downward proliferation of the surface epithelium under the stimulus of irritation and chronic inflammation, finally becoming detached and losing all connection to the mucosal mem-

[1] From the Department of Radiology, The New York Hospital-Cornell Medical Center, New York, N. Y. Accepted for publication in September 1956.

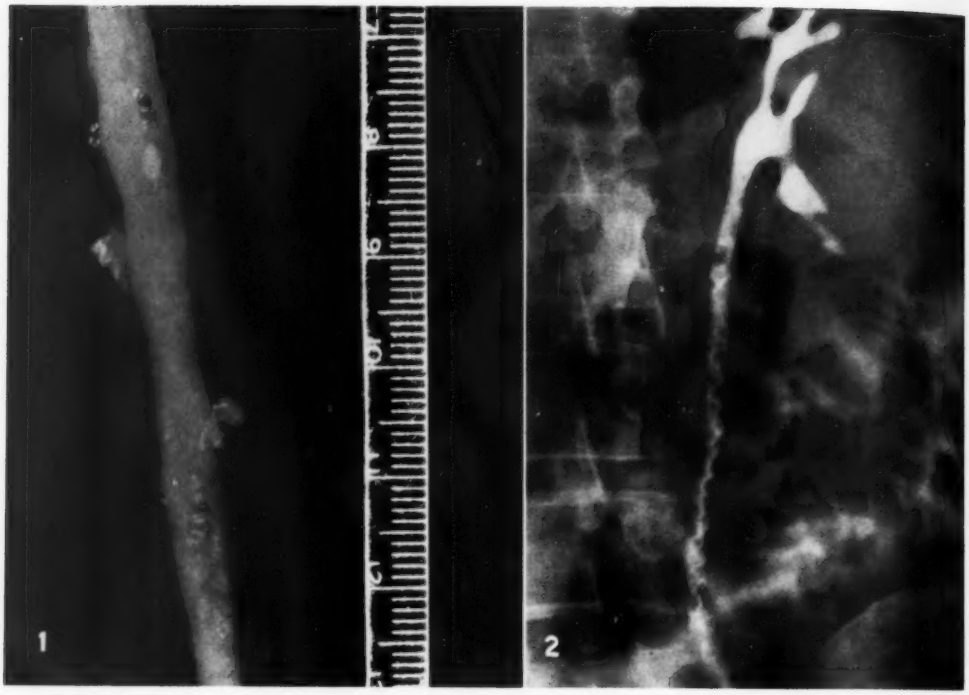


Fig. 1. Autopsy specimen showing several small cysts of ureteritis cystica.
Fig. 2. Urogram showing extensive unilateral ureteritis cystica. Marginal scalloping nicely demonstrated.

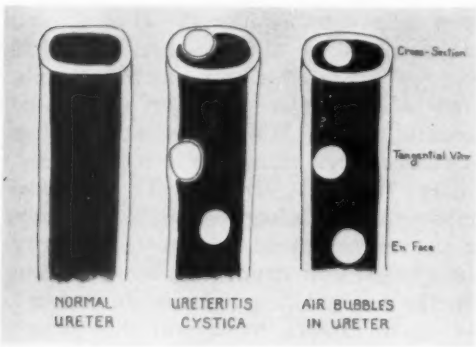


Fig. 3. Drawing illustrating the filling-defects produced by the submucosal lesions of ureteritis cystica and air bubbles.

brane. Numerous other writers, as Lubarsch (13), Aschoff (14), Radtke (15), Motz and Cariani (16), Liebreich (17), Harris (18), Bothe and Cristol (19), and Pessin (4), have supported von Brunn's explanation, which is now widely accepted. Marckwald (20) in 1898 found ureteritis and cystitis cystica in a newborn infant and concluded that inflammation was not necessary to produce von Brunn's nests. Giani (21), in 1906, produced cysts and cell nests in rabbit bladders by curetting them through suprapubic wounds. Morse (22) in 1928 studied 125 consecutive autopsy cases and found microscopic evidence of cysts or the cell nests of von Brunn in 108, in 63 of which there was evidence of inflammatory changes. He pointed out that glandular structures are not of normal occurrence in the urinary tract above the trigone. Epithelial buds, nests, and cysts, which are not found normally, are the result of inflammation. Morse agreed with von Brunn that the cysts are the result of central degeneration within the cell nests.

The first clinical diagnosis of ureteritis cystica was made by Jacoby (23) in 1929, and in 1933 Kindall (24) made a urographic diagnosis, later confirmed by biopsy.

CASE MATERIAL

The case material utilized in this study was taken from the New York Hospital pavilion admissions over a twenty year period, 1936–56. These cases, totaling 57, were classified as ureteritis cystica, pyelitis cystica, and cystitis cystica. The diagnoses were as follows:

Ureteritis cystica	17 cases
Cystitis cystica	32 cases
Pyelitis cystica	2 cases
Ureteritis cystica and pyelitis cystica	2 cases
Ureteritis cystica, pyelitis cystica, and cystitis cystica	2 cases
Ureteritis cystica and cystitis cystica	2 cases
Bilateral ureteritis cystica or pyelitis cystica	12 cases
Unilateral ureteritis cystica or pyelitis cystica	13 cases
Evidence of previous or past infections	52 cases

Of the 57 patients, 32 were females and 25 males, ranging in age from nine to eighty-eight years, with the greatest number between the ages of fifty and sixty. Three of the series were Negroes. All permutations of characteristic changes in pelvis, ureter, and bladder were included except for the combination of pyelitis cystica and cystitis cystica. Of the cases involving the renal pelvis or ureter, 13 were unilateral and 12 bilateral. The remaining 32 cases were of cystitis cystica. In 30 of these diagnosis was made by cystoscopy and in 11 was confirmed by biopsy. Two cases were found at autopsy.

The diagnosis of pyelitis and ureteritis cystica was made by intravenous pyelography, retrograde pyelography, surgical pathology, or autopsy. Fourteen cases were diagnosed on histologic examination. Frequently retrograde studies confirmed findings which were inconclusive or merely suspicious on the intravenous pyelogram. In several instances where the diagnosis was made postoperatively on examination of the surgical specimen or at autopsy, a review of pyelograms showed the presence of the disease.

Methods Employed in Diagnosis

A.	Ureteritis cystica and pyelitis cystica	
	1. Intravenous pyelogram	9 cases
	2. Retrograde pyelogram	6 cases
	3. Autopsy	6 cases
	4. Surgical specimen	4 cases
B.	Cystitis cystica	
	1. Cystoscopy	30 cases
	2. Autopsy	2 cases

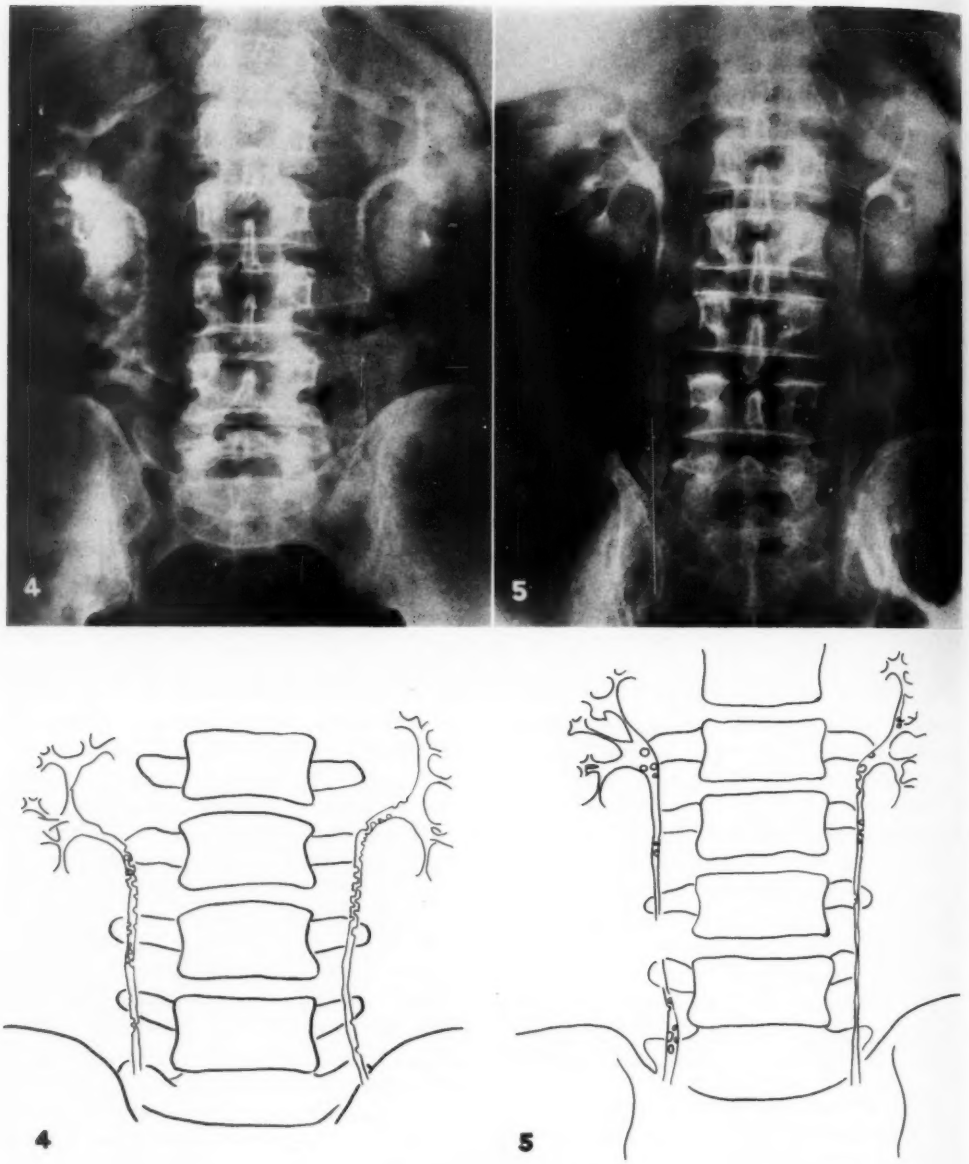
Definite evidence of urinary tract infection was found in 52 cases. Of the remaining 5 patients, 1 had diabetes, 1 benign prostatic hypertrophy, and 3 neither urinary tract infection nor a condition predisposing to it.

ROENTGEN FEATURES

The lesions of pyelo-ureteritis cystica can occur at any point along the renal pelvis and ureter but are most frequently found in the proximal third of the ureter. The typical pyelographic appearance is that of multiple small, round, lucent defects which cause a characteristic scalloping of the ureteral margins when seen in profile. The scalloping is produced by the projection of the submucosal cysts into the lumen and represents an important differential feature of this disease (Figs. 2 and 3).

The cysts are usually scattered and discrete but may occasionally cluster in small groups. They may be either unilateral or bilateral in distribution. Because of the frequent association with chronic inflammatory disease of the urinary tract, it is not surprising to find radiographic changes of both pyelo-ureteritis cystica and chronic pyelonephritis occurring concomitantly (Figs. 6 and 7).

The lesions of pyelo-ureteritis cystica are frequently poorly demonstrated on intravenous pyelograms. Every attempt should be made to improve visualization and to raise the quality to a point comparable with a retrograde study. Careful attention should be given to the following details: (*a*) cleaning the bowel by withholding the evening meal and administering laxatives and cleansing enemas; (*b*) improving density of the excretory urogram by dehydrating the patient and by using higher concentrations of the contrast medium



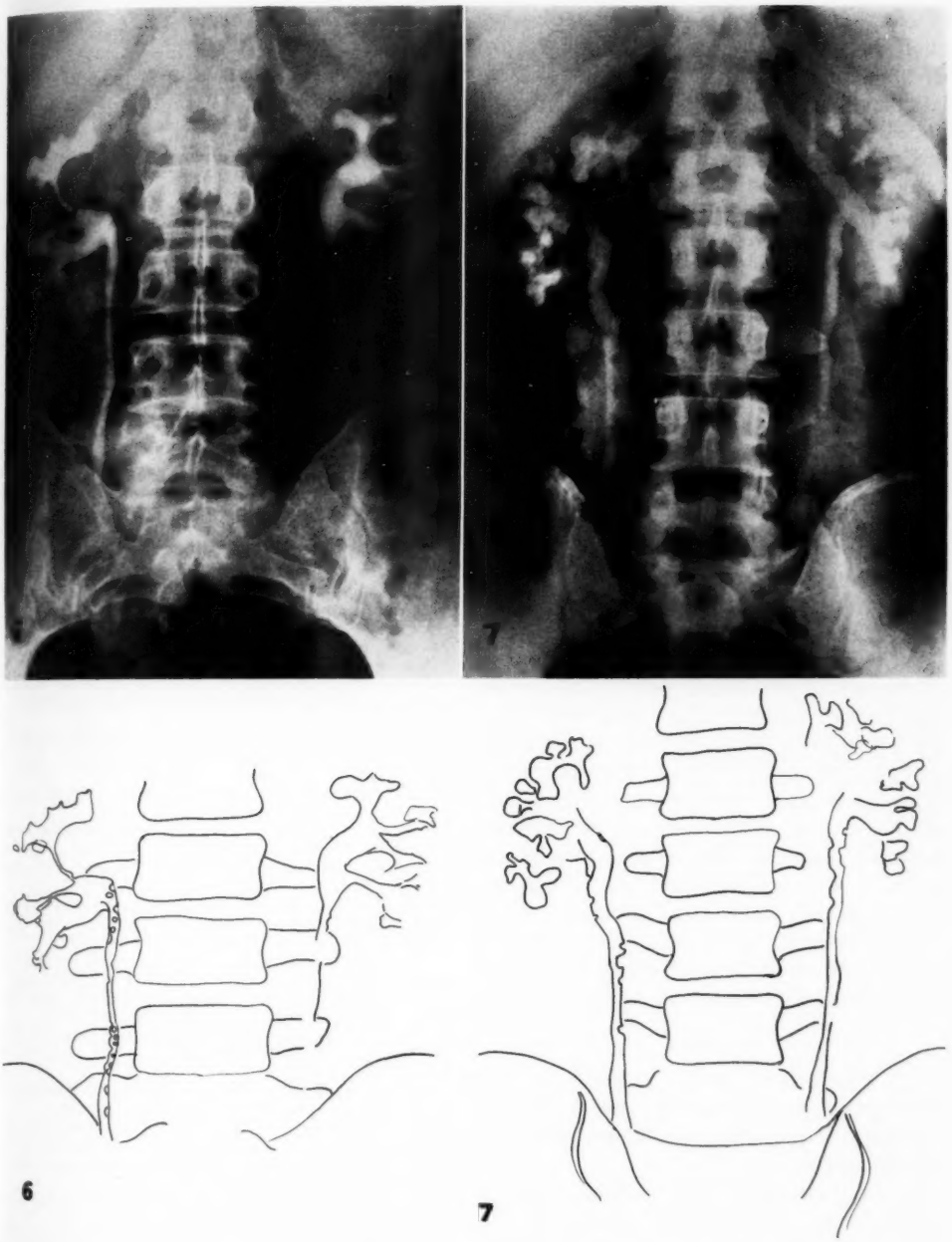
Figs. 4 and 5. Bilateral ureteritis cystica.

when necessary; (*c*) aiding ureteral delineation by causing partial urinary stasis with the aid of abdominal compression and a moderate Trendelenburg position; (*d*) diluting the contrast substance for retrograde studies, if necessary, to prevent obliteration of the smaller cysts.

DIFFERENTIAL DIAGNOSIS

The following conditions should be considered in the radiographic differential diagnosis of pyelo-ureteritis cystica:

Air bubbles, accidentally injected in retrograde pyelography, may be a source of speculative diagnosis. They have a



Figs. 6 and 7. Two cases of ureteritis cystica in patients with chronic pyelonephritis.

characteristic clarity and smooth, circular configuration. They are, of course, inconstant in location and move freely within the ureter with positional changes. Excretory urograms of good quality or retrograde studies with proper technic should eliminate this problem.

Tuberculous pyelo-ureteritis may be recog-

nized by numerous and complicated changes dependent upon the degree of involvement. Ragged ulcerations causing hazy and fuzzy marginal outlines may be noted. Irregularities in the caliber of the ureter may occur, with alternating areas of narrowing and dilatation. Later changes may produce classical beading, strictures, or ureteral shortening (26).

Blood clots may be responsible for lucent defects in the urinary tract. They are relatively large and irregular in shape. The bleeding source may be evident from the history and clinical findings.

Pyelonephritis, pyelitis and papillary necrosis can produce *cellular débris*, which may lodge within the lumen of the pelvis and ureter (26).

Non-opaque *calculi* are easily differentiated from the more numerous lesions of pyelo-ureteritis cystica. Lucent calculi are commonly few in number and unilateral in location. They may be associated with colicky pain or may produce obstruction.

Tumors of the renal pelvis and ureter may have broad bases with relatively fixed positions. The exceptions are small polyps and pedunculated tumors. Evidence of mucosal destruction or invasion, possibly with extravasation of contrast medium, may be found with malignant tumors. Ureteral obstruction, with proximal dilatation, may be a feature.

Varicose ureteral veins, causing multiple smooth and well defined filling defects on the ureterogram, have been reported (27).

SUMMARY

1. Ureteritis cystica, pyelitis cystica, and cystitis cystica are similar conditions resulting from chronic inflammation in the urinary tract.

2. According to von Brunn's theory, which is the most widely accepted, cell nests develop from downward proliferation of lining epithelium, separate, and undergo central degeneration to become cysts.

3. A series of 57 cases is presented, including 25 cases of pyelo-ureteritis cystica and 32 of cystitis cystica. Evidence of urinary tract infection was found in 52 cases.

4. The typical roentgen appearance is that of multiple small, round, lucent defects producing a characteristic scalloping of the ureteral margins when seen in profile.

With pyelograms of good quality, the differential diagnosis is not difficult.

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REFERENCES

1. BIEDERBACH, W. D., COOK, P. H., AND GOODALE, R. H.: Pyelo-Ureteritis Cystica, with Report of a Case. Am. J. Roentgenol. **31**: 778–783, June 1934.

2. MAXIMOW, A. A., AND BLOOM, W.: A Textbook of Histology. Philadelphia, W. B. Saunders Co., 5th ed., 1948, Vol. I, p. 496.

3. VON BRUNN, A.: Ueber drüsenähnliche Bildungen in der Schleimhaut des Nierenbeckens des Ureters und der Harnblase beim Menschen. Arch. f. mikr. Anat. **41**: 294–302, 1893.

4. PESSIN, S. B.: Multiple Cysts of Ureters (Ureteritis Cystica); 7 Cases, 2 Associated with Congenital Polycystic Kidneys. Urol. & Cutan. Rev. **43**: 752–759, November 1939.

5. MORGAGNI, J. B.: De sedibus et causis morborum per anatomen indagatis. (The Seats and Causes of Diseases Investigated by Anatomy.) Abridged and Elucidated, with copious notes by William Cooke. London, Longman, 1822, Vol. II, pp. 316–319; 411–412.

6. RAYER, P. F.: Traité des maladies des reins. Atlas. Paris, J. B. Baillière, 1837. Plate 52, Figures 2, 3, and 4.

7. VIRCHOW, R.: Die krankhaften Geschwülste. Berlin, August Hirschwald, 1863, p. 246.

8. ROKITANSKY, C.: Lehrbuch der pathologischen Anatomie, Wien, Braumüller, 1842–1846. English translation, Manual of Pathological Anatomy, London, 2d ed., 1861.

9. LITTEN, M.: Ureteritis chronica cystica polyposa nebst cystischer Degeneration der Niere. Virchow's Arch. f. path. Anat. **66**: 139–144, 1876.

10. VON LIMBECK, R.: Zur Kenntniss der Epithelcysten der Ureteren. Ztschr. f. Heilk. **8**: 55–66, 1887.

11. EVE, F. S.: Psorospermial Cysts of Both Ureters. Tr. Path. Soc. London **40**: 444–446, 1889.

12. URQUHART, A. L.: Cyst Formation in the Ureter, Associated with Bilharziasis. Brit. J. Urol. **3**: 21–25, March 1931.

13. LUBARSCH, O.: Ueber Cysten der ableitenden Harnwege. Arch. f. mikr. Anat. **41**: 303, 1893.

14. ASCHOFF, L.: Ein Beitrag zur normalen und pathologischen Anatomie der Schleimhaut der Harnwege und ihrer drüsigen Anhange. Virchow's Arch. f. path. Anat. **138**: 119, 1894.

15. RADTKE, E.: Beiträge zur Kenntnis der Ureteritis cystica. Königsberg, 1900.

16. MOTZ, B., AND CARIANI, A.: Contribution à l'étude des adénomes kystiques de l'appareil urinaire. Ann. d. mal. d. org. genito-urin. **22**: 1305–1315, 1904.

17. LIEBREICH, A.: Ein Fall von Ureteritis Cystica. Tübingen, 1906.

18. HARRIS, H.: Cysts of the Ureter. Am. Med. **3**: 731–734, 1902.

19. BOTHE, A. E., AND CRISTOL, D. S.: Cystic Disease of the Upper Urinary Tract. Pyelitis Cystica

and Ureteritis Cystica. Am. J. Roentgenol. **48:** 787–798, December, 1942.

20. MARCKWALD: Die multiple Cystenbildung in der Ureteren und der Harnblase, sog. Ureteritis cystica. München. med. Wchnschr. **45:** 1049–1053, 1898.

21. GIANI, R.: Neuer experimenteller Beitrag zur Entstehung der Cystitis cystica. Centralbl. f. allg. Path. u. path. Anat. **17:** 900–902, 1906. Also: Beitr. z. path. Anat. u. z. allg. Path. **42:** 1–22, 1907.

22. MORSE, H. D.: Etiology and Pathology of Pyelitis Cystica, Ureteritis Cystica and Cystitis Cystica. Am. J. Path. **4:** 33–50, January 1928.

23. JACOBY, M.: Hydronephroider Krebs der Niere kombiniert mit Nierenbeckenstein, papillärer Krebs des Nierenbeckens und Harnleiters, Ureteritis Cystica. Ztschr. f. Urol. **23:** 718–723, 1929.

24. KINDALL, L.: Pyelitis Cystica and Ureteritis Cystica. Report of a Case Diagnosed by Urography and Confirmed by Biopsy, with Outline of Treatment. J. Urol. **29:** 645–659, June 1933.

25. HEUCK, F.: Die Pyelo-Ureteritis cystica im Röntgenbild. Fortschr. a. d. Geb. d. Röntgenstrahlen **71:** 960–969, October 1949.

26. BRAASCH, W. F., AND EMMETT, J. L.: Clinical Urography: An Atlas and Textbook of Roentgenologic Diagnosis. Philadelphia, W. B. Saunders Co., 1951.

27. BERMAN, M. H., AND COPELAND, H.: Filling Defects of Ureterogram Caused by a Varicose Ureteral Vein. J. Urol. **70:** 168–170, August 1953.

28. KNUTSSON, F.: Roentgen Appearance in Ureteritis Cystica. Report of 2 Cases. Acta radiol. **16:** 43–47, 1935.

29. STIRLING, W. C.: Extensive Bilateral Pyelo-Uretero-Cystitis Cystica and Glandularis Producing Pyonephrosis—Nephrectomy; Report of Cases. J. Urol. **48:** 237–243, September 1942.

SUMMARIO IN INTERLINGUA

Ureteritis Cystic e Pyelitis Cystic: Revista de Casos e Criterios Roentgenologic

Ureteritis cystic, pyelitis cystic, e cystitis cystic es simile conditiones que resulta ab inflammation chronic del vias urinari. Secundo le theoria le plus generalmente acceptate, nidos de cellulas se disveloppa per proliferation in basso que occurre in le revestimento epithelial, se separa, e experientia un degeneration central de maniera que illos deveni cystes. Es presentate un serie de 57 casos: 25 de pyelo-ureteritis cystic e 32 de cystitis cystic. Signos de infection del vias urinari esseva trovate in 52 casos.

Le typic apparentia roentgenographic presenta multiple minor defectos ronde e lucente que produce un dentation characteristic del margine ureteral quando on lo vide in profilo. Super le base de pyelogrammas de qualitate superior, le diagnose differential non es difficile a effectuar.

Mediastinal Parathyroid Carcinoma with Metastases

Report of a Case and Review of the Literature[1]

IRVING WEISSMAN, M.D.,[2] JAMES P. WORDEN, M.D.,[3] and JAMES M. CHRISTIE, M.D.[4]

REPORTS OF ONLY 6 cases of functional parathyroid carcinoma with metastases could be found in the literature, and none of these arose in the mediastinum. Castleman (4), of the Massachusetts General Hospital, found 20 per cent of parathyroid adenomas to be mediastinal. In the files of the Armed Forces Institute of Pathology (1) there are no mediastinal parathyroid carcinomas and only one mediastinal parathyroid adenoma.

The case presented here was first reported in a symposium on mediastinal tumors (3) as a mediastinal adenoma of the parathyroid gland. Subsequently recurrent mediastinal masses and symptoms developed, leading to the patient's death. On postmortem examination, the masses in the mediastinum, in addition to multiple metastatic areas, proved to be parathyroid carcinoma.

CASE REPORT

A 46-year-old farmer was first seen in the Christie Clinic in September 1946 because of urinary frequency, dysuria, and fever. He had been subject to recurrent right flank pain since the age of thirty-two and in 1939 had been hospitalized for hematuria. Roentgenograms showed stones in the right renal pelvis and ureter, subsequently removed surgically. In 1940 a left nephrolithotomy was necessary. The patient convalesced rapidly on medical management, although the history at that time suggested the possibility of hyperparathyroidism. Neck exploration was refused.

In August 1949, the patient was again in the hospital briefly, for recurrent urinary tract infection. A routine chest film demonstrated a huge anterior mediastinal mass extending well into the right hemithorax (Fig. 1). This was obviously asymptomatic and radiographically was interpreted as a

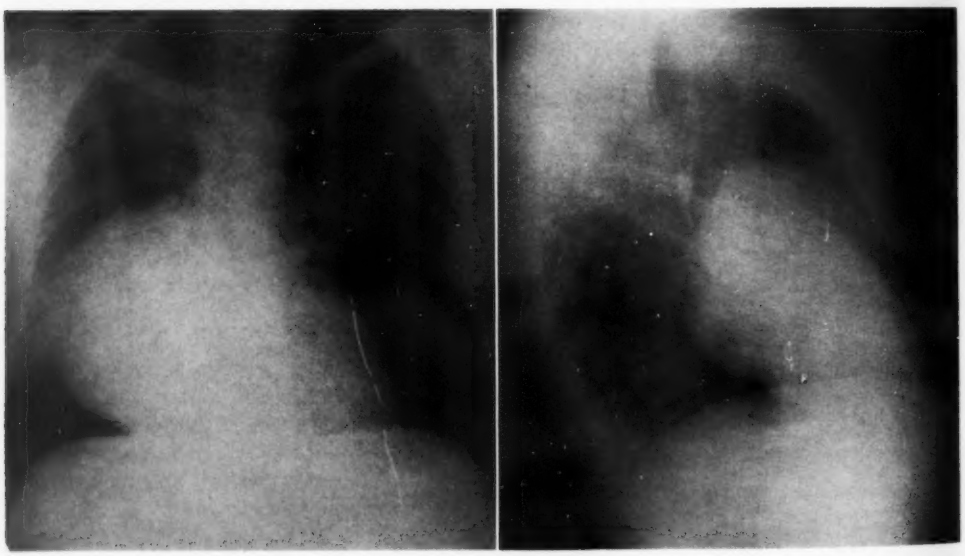

Fig. 1. Preoperative chest films showing large, well circumscribed anterior mediastinal tumor, completely asymptomatic, believed to be a dermoid cyst.

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TABLE I: BLOOD CHEMISTRY ON SUCCESSIVE EXAMINATIONS

	Dec. '50	Aug. '51	Dec. '53	June '55	Dec. '55
Serum calcium	15.0	14.2	14.9	12.9	...
Serum phosphorus	2.8	4.0	2.0	2.5	3.3
Alkaline phosphatase	...	...	...	6.2	...
Sulkowitch test	+++	...	++++	neg.	++
Urinary calcium (24-hr.)	425	...	...	...	...
Serum proteins	6.2	...	...	...	...
Non-protein nitrogen	44.5	...	37	44.5	73

benign tumor, dermoid cyst being given first consideration in diagnosis. Operation was undertaken on Nov. 17, 1949, disclosing a solid gray mass as large as a football, densely adherent to the medial aspect of the right lung and originating by a broad base in the upper anterior mediastinum. There were no local extensions, and removal, by sharp dissection, was apparently complete (Fig. 2).

The gross pathological description was "a partially encapsulated lobulated mass 15.5 × 18 cm. in its greatest dimension. . . soft and friable in consistency. Areas of hemorrhage and necrosis are evident in the central portion. Strands of connective tissue divide the mass into lobules." Microscopically, the section showed "interlacing cords of cells with closely spaced small, dark nuclei and poorly defined cytoplasm. There are numerous clear spaces in the masses, some containing mucin, others a small blood vessel. In general, the growth is orderly, but the cellularity and increased chromatin content of the nuclei indicate a very active tumor with possible low-grade malignant potential." The pathological conclusions at this time showed a difference of opinion. The local pathologist considered the tumor to be an adenocarcinoma. Dr. Edith Parkhill, pathologist at the Mayo Clinic (12), believed the tissue to be ectopic parathyroid adenoma. This diagnosis was concurred in independently by members of the Armed Forces Institute of Pathology, Washington, D. C. (1).

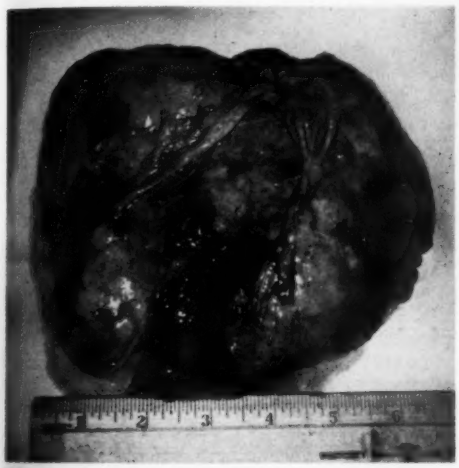

Fig. 2. Surgical specimen. Large solid mediastinal mass removed as completely as possible and diagnosed as an ectopic parathyroid adenoma (Edith Parkhill, M.D., Pathologist, Mayo Clinic).

Fig. 3. Roentgenogram showing multiple renal calculi which recurred again and again during the span of the patient's life.

The patient did well following thoracotomy, and chest films showed no evidence of a residual or recurrent mediastinal mass. Attacks of urinary tract infection with flank pain continued, and in November 1950, x-ray examination demonstrated increase in size and number of bilateral renal calculi (Fig. 3). A right nephrolithotomy was done on Dec. 2, 1950, with removal of cortical and pelvic stones from the right kidney. Laboratory studies of the blood confirmed the clinical impression of hyperparathyroidism (Table I). Neck surgery was again refused.

For the next few years, the patient enjoyed moderately good health, although he did suffer recurrent bouts of pyelonephritis, controlled by appropriate antibiotics. In August 1953, a chest film revealed a recurrent mediastinal tumor, lobulated in shape and extending from both hili,

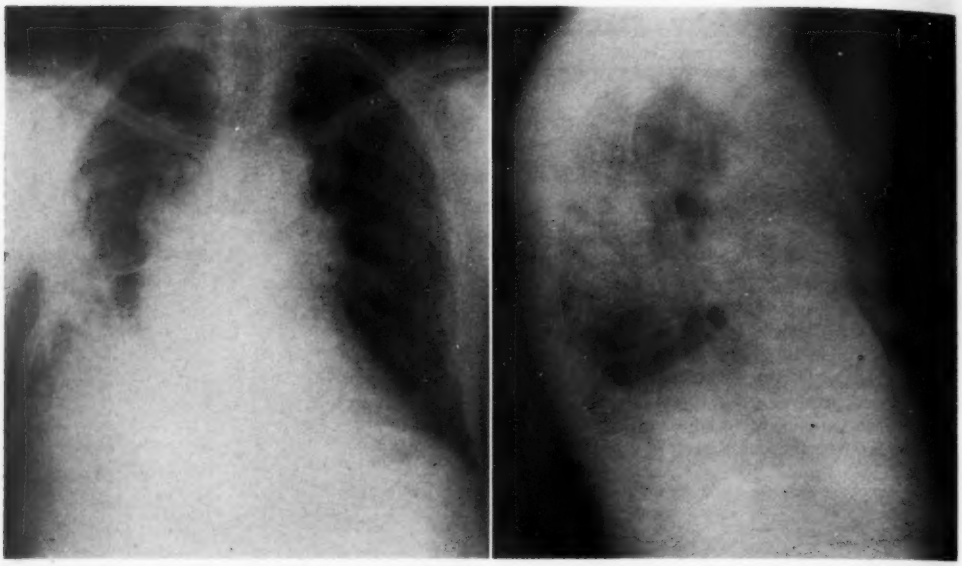

Fig. 4. Post-thoracotomy chest film showing recurrent lobulated mediastinal masses, non-responsive to x-ray therapy, associated with an apparent metastatic nodule in the right lower lobe. Post-thoracotomy pleural thickening on the right side.

suggestive of lymphoma (Fig. 4). A diagnostic trial of x-ray therapy to the mediastinum—6 × 200 r, through an anterior and posterior port, for a total dose of 2,400 r (in air)—produced no reduction in the size of the mass.

New and larger renal and ureteral calculi appeared in December 1953. Laboratory studies showed abnormal blood calcium and phosphorus levels again consistent with hyperparathyroidism (Table I). A skeletal roentgen survey, however, including skull and hand films, revealed no evidence of osteitis fibrosa cystica or other changes suggestive of hyperparathyroid disease. The exact nature of the mediastinal mass continued to be a baffling diagnostic problem. Among the differential diagnoses considered were: lymphoma, malignant thymoma, parathyroid carcinoma, and adenocarcinoma (primary site undetermined).

During subsequent months, in spite of supportive treatment, the course continued downhill, with dysuria, weight loss, weakness, and evidence of a bleeding peptic ulcer. An additional course of palliative irradiation to the chest was of no benefit. Blood and urine studies showed little variation from previous examinations. At no time was there x-ray evidence of bone disease. The patient died on Dec. 21, 1955, in a state of peripheral vascular collapse.

Pertinent postmortem findings were as follows:

Mediastinum: Occupying the anterior mediastinum and extending upward into the neck was a large, hard tumor (Fig. 5) adherent to the base of the heart, the trachea, and the right lung. The mass was firm and nodular throughout. Sectioned surfaces were lobulated, with extensive areas of hemorrhage. Imbedded in the pleura were multiple nodular masses similar to that in the mediastinum. The main tumor was firmly adherent to the descending aorta, producing marked compression of the lumen of the aorta.

Lungs: The lower lobe of the right lung was occupied by a mass similar to that described in the mediastinum. Sectioned surfaces were deeply hemorrhagic. The left lung was normal.

Kidneys: The kidneys together weighed 280 gm. The capsules were thickened and stripped with difficulty. In the right renal pelvis and calyces were three brownish calculi measuring up to 1 cm. in diameter. The left renal pelvis was dilated and contained multiple calculi up to 3 × 1.8 cm. in their greatest dimensions. The ureters were slightly dilated. The walls of the urinary bladder were thickened and the mucosal surfaces were trabeculated.

Suprarenal Glands: The right suprarenal gland weighed 45 gm. and the left 30 gm. Both were firm and nodular. Embedded in the right suprarenal was a nodule of tumor, 2.8 cm. in diameter, similar to that in the mediastinum (Fig. 6). Embedded in each suprarenal gland were multiple smaller encapsulated nodules, measuring up to 1.8 cm. in diameter.

Pathological Diagnosis (Dr. Max Appel, Consulting Pathologist, Christie Clinic): Malignant thymoma with metastases to right lung and right suprarenal gland; marked old adhesive pleuritis;

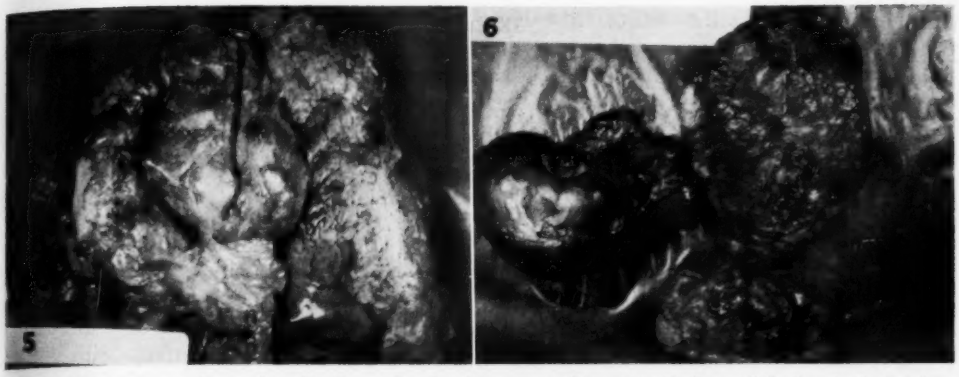

Fig. 5. Postmortem specimen of mediastinum showing firm mass adherent to the base of the heart, the trachea, and the right lung. *Pathological diagnosis:* Parathyroid carcinoma.

Fig. 6. Postmortem specimen of right kidney and suprarenal gland. The kidney was the site of multiple brownish calculi. The suprarenal gland contained a nodule of tumor similar to that in the mediastinum.

bilateral bronchopneumonia; chronic pyelonephritis and bilateral nephrolithiasis; multiple cortical adenomata of adrenal glands.

Microscopic slides of the mediastinal tissues were submitted to the Armed Forces Institute of Pathology, Washington, D. C. (1), with the following response: "The case was reviewed by members of the A.F.I.P. staff as well as by two visiting consultant pathologists, Dr. Malcolm Dockerty of the Mayo Clinic and Dr. Lauren Ackerman of Washington University Medical School. It was the consensus, including the opinions of the two consultants and of this reviewer, that this tumor was a functioning parathyroid carcinoma. Possibly it represents a malignant transformation of a parathyroid adenoma." (Fig. 7).

The tissue slides were also submitted to Dr. Emmerick Von Hamm (14), Pathologist at Ohio State University, who reported: "The tumor slide you submitted seems to me a carcinoma of the parathyroid with some functioning and some nonfunctioning elements present on the slide."

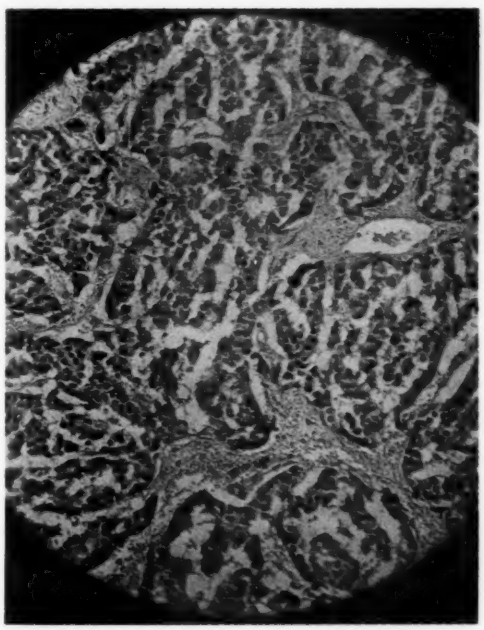

Fig. 7. Photomicrograph of mediastinal tumor, postmortem specimen. *Pathological diagnosis:* Parathyroid carcinoma. ×90

DISCUSSION

It is obvious that differences of opinion exist between the pathologists reviewing this case. The majority opinion, however, is certainly in favor of parathyroid carcinoma, the diagnosis reached independently by several well known pathologists across the country. This opinion is consistent with the clinical evidence of recurrent nephrolithiasis and is supported by the laboratory evidence of persistently elevated serum calcium and decreased serum phosphorus plus qualitative and quantitative increase in urinary excretion of calcium. Pugh (13) states that at the Mayo Clinic all cases of urinary tract calculi are investigated for evidence of hyperparathyroid disease, with a remarkably high yield of parathyroid hyperfunction.

It is readily apparent, in reviewing the literature, that primary carcinoma of the parathyroid glands is rare. It is

also evident that the exact histologic criteria necessary for such a diagnosis are equivocal. De Wesselow and de Wardener (5) state that many clinical benign cases have been claimed as malignant on the basis of the microscopic appearance. Norris (11), in 1947, after reviewing 25 reported cases of parathyroid cancer, dogmatically concluded that cancer of the parathyroids does exist. Perhaps the occurrence of distant metastases is the most important factor indicating malignancy. Black and Haynes (2), Meyer, Rosi, and Ragins (10), and King and Wood (9) all report cases of parathyroid cancer with remote metastases.

In most of the recorded cases of parathyroid carcinoma the evidence of malignancy lies in the tendency of the tumor to recur locally, with return of symptoms of parathyroid intoxication. Fretheim and Lange (8) feel strongly that in some of the reported cases the diagnoses are quite uncertain, without proof that the tumor was malignant.

Typical cystic changes in the bones are not always found in parathyroid carcinoma. In this connection Norris (11) states that parathyroid cancer may or may not be endocrinologically active. Fifty per cent of his 25 reviewed cases showed hypercalcemia and skeletal decalcification. In the case described here, there was never any evidence of osseous change. This includes a failure to find subcortical decalcification of the terminal phalanges of the hands described by Pugh (13).

Finally there are in the literature no acceptable cases of parathyroid mediastinal carcinoma. This is substantiated by Woolner, Keating, and Black (15), reporting on 140 cases of primary hyperparathyroidism. In the case published by Young and Emerson (16) surgical exploration of the mediastinum was done but no parathyroid tissue was found. Ellis and Barr (7) reported in 1951 a case of metastasizing carcinoma of the parathyroids with osteitis fibrosa cystica and extensive calcinosis. The tumor was considered malignant because of local recurrence, regional lymphatic spread, and metastases to lungs and liver. Dorgeloh (6) reaches a similar conclusion as to the rarity of true malignant adenomas of the parathyroids causing hyperparathyroidism.

In the case presented here, the evidence of local recurrence, in addition to metastases to the lung and adrenal gland, is in accord with the basic criteria for malignancy. The absence of bone changes in the presence of abnormal calcium and phosphorus blood levels is not unusual in cases of hyperfunctioning parathyroid glands, as is substantiated by the literature.

SUMMARY

A case of an unusually large mediastinal parathyroid adenoma associated with nephrolithiasis and hypercalcemia is presented. Surgical removal of the adenoma was followed, after about three years, by malignant recurrence in the mediastinum, with distant metastases eventually leading to death. The case is unusual in that, in spite of the large size of both the benign and malignant parathyroid tumor, no evidence of osteitis fibrosa cystica occurred. The diagnosis was confirmed by the abnormal calcium and phosphorus levels in the blood, and at necropsy. A review of the literature is presented.

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REFERENCES

1. Armed Forces Institute of Pathology, Washington, D. C. Personal communication.
2. BLACK, B., AND HAYNES, A. L.: Hyperfunctioning Carcinoma of Parathyroid Origin with Local Recurrence and Metastasis: Subsequent Report of a Case. Proc. Staff Meet., Mayo Clin. **26**: 309–312, Aug. 1, 1951.
3. CHRISTIE, J. M., AND WEISSMAN, I.: Mediastinal Tumors. Illinois M. J. **104**: 242–252, October 1953.
4. COPE, O., NARDI, G. L., AND CASTLEMAN, B.: Carcinoma of the Parathyroid Glands: Four Cases Among 148 Patients with Hyperparathyroidism. Ann. Surg. **138**: 661-671, October 1953.
5. DE WESSELOW, O. L. V., AND DE WARDENER, H. E.: Carcinoma of the Parathyroid Gland with Hyperparathyroidism. Lancet **1**: 820–823, May 14, 1949.
6. DORGELOH, J. R.: Parathyroid Carcinoma Causing Hyperparathyroidism. California Med. **69**: 138–140, August 1948.
7. ELLIS, J. T., AND BARR, D. P.: Metastasizing Carcinoma of Parathyroid Gland with Osteitis Fibrosa Cystica and Extensive Calcinosis. Am. J. Path. **27**: 383–405, May-June 1951.

8. FRETHEIM, B., AND LANGE, H. F.: Carcinoma of the Parathyroid with Hyperparathyroidism. Acta endocrinol. **1**: 203–216, 1948.
9. KING, E. S. J., AND WOOD, B.: Parathyroid Tumor with Visceral Metastases. J. Path. & Bact. **62**: 29–35, January 1950.
10. MEYER, K. A., ROSI, P. A., AND RAGINS, A. B.: Carcinoma of Parathyroid Gland. Surgery **6**: 190–200, August 1939.
11. NORRIS, E. H.: Collective Review: Parathyroid Adenoma. Study of 322 Cases. Internat. Abstr. Surg. **84**: 1–41, January 1947; in Surg., Gynec. & Obst., January 1947.
12. PARKHILL, E. (Mayo Clinic, Rochester, Minn.): Personal communication.
13. PUGH, D.: Roentgenologic Diagnosis of Diseases of Bones. Reprinted from Diagnostic Roentgenology, Ross Golden (Editor). Baltimore, Williams & Wilkins Co., 1950–1951.
14. VON HAMM, E. (Medical School, Ohio State University): Personal communication.
15. WOOLNER, L. B., KEATING, F. R., JR., AND BLACK, B.: Tumors and Hyperplasia of the Parathyroid Glands; Review of Pathological Findings in 140 Cases of Primary Hyperparathyroidism. Cancer **5**: 1069–1088, November 1952.
16. YOUNG, J. H., AND EMERSON, K., JR.: Parathyroid Carcinoma Associated with Acute Parathyroid Intoxication. Ann. Int. Med. **30**: 823–837, April 1949.

SUMMARIO IN INTERLINGUA

Carcinoma Parathyroide Mediastinal con Metastases. Reporto de un Caso e Rivista del Litteratura

Es presentate un caso de un inusualmente grande adenoma parathyroide mediastinal, associate con neophrolithiasis e hypercalcemia. Le ablation chirurgic del adenoma esseva sequite post un intervallo de circa tres annos per un recurrentia maligne in le mediastino, con metastases distante que ultimemente resultava in le morte del patiente. Le caso es inusual, proque—in despecto del magnitude del benigne e del maligne tumor parathyroide—il occurreva nulle signo de osteitis fibrose cystic. Le diagnose esseva confirmate per le anormal nivellos de calcium e phosphoro in le sanguine e per le constatationes necroptic.

A Case of Accidental Puncture Contaminated with Th^{227}

Studies on Elimination and Residual Body Activity[1]

P. F. GUSTAFSON, M.S., L. D. MARINELLI, M.A., and E. A. HATHAWAY, M.D.

DURING THE COURSE of her assigned duties, a member of the Argonne National Laboratory staff accidentally punctured her right index finger with a pair of forceps which, two days previously, had been dipped into a chloride solution of Th^{227} freshly extracted from an equilibrium mixture of Ac^{227} (1). Thus, the elements introduced into the body consisted essentially of Th^{227} plus a two-day growth of its daughters.

Table I indicates the relevant properties of the Actinium family. From the values listed, it will be noted that, aside from Ra^{223}, all the Th^{227} daughters are short-lived; hence they quickly reach radioactive equilibrium with the Ra^{223} before being excreted from the body.[2] These circumstances lead to great simplification in analysis, since only the first two elements of the chain will have any significant probability of being excreted.

TABLE I: ACTINIUM SERIES (15)

Isotope	Half-life	Emission	Gamma-Ray Energy (kev)
Ac^{227}	22 yr.	β	
Th^{227}	19 days	α	50, 80, 240, 258
Ra^{223}	11 days	α	81, 154, 268, 348
Em^{219}	4 sec.	α	267, 392, 589
Po^{215}	2×10^{-3} sec.	α	
Pb^{211}	36 min.	β	404, 425, 829
Bi^{211}	2 min	α	350
Tl^{207}	5 min	β	
Pb^{207}	Stable		

TRANSPORT OF TH AND RA FROM THE WOUND

Initially, monitoring of the hand in the vicinity of the puncture wound revealed a count of 60,000 to 80,000 alpha disintegrations per minute. The usual type of skin decontamination procedures (prolonged washings with detergent, scrubbing, etc.) were employed without much success. In addition, calcium disodium ethylenediaminetetraacetate (CaEDTA) was used to irrigate the wound area, and this was followed with half-strength concentrated hydrochloric acid. After these procedures there was still a count of about 17,000 alpha disintegrations per minute.

The circumstances of the accident were such that it was believed that only thorium could have contaminated the wound, and this in inconsequential amounts. Four days later, laboratory reports became available indicating the amount of alpha activity in urine and feces excreted during the first twenty-four hours after the injury. Since these quantities were high, concern was expressed that the large amount of alpha-emitting thorium known to be in the body might be accompanied by a smaller but still significant amount of the beta-emitting Ac^{227}. This matter could not be resolved quickly, since the answer could be provided only by time-consuming chemical separations and radioactive growth studies. Consequently, on the fourth day after the injury, the wound and adjacent skin were surgically excised. While this procedure was being performed, the operative site was continuously irrigated with 0.9 per cent saline in the hope that during the surgical manipulations—which took a very brief time—any dislodged radioactive material would be washed away. In addition, the patient was given 1.0 gm. of CaEDTA in 250 c.c. of 0.9 per cent saline intravenously over a forty-five minute period. The sample of skin was saved for analysis, and the wound was closed with interrupted surgical sutures.

Immediately before and after surgery,

[1] Work performed under the auspices of the Atomic Energy Commission. From the Argonne National Laboratory, Lemont, Ill. (P. F. G., Division of Biological and Medical Research; L. D. M., Radiological Physics Division; E. A. H., Health Division). Accepted for publication in August 1956.

[2] This statement applies also to gaseous Em^{219} whose half life is only 4 seconds.

readings of the gamma activity remaining in the finger were taken by placing it at a distance of 10 cm. from the face of a scintillation counter. It should be emphasized that these exploratory readings, including the first two to be described here, were all made by using a single-channel pulse height analyzer in conjunction with a NaI(Tl) crystal and an RCA-5819 photomultiplier tube.[3]

Spectral data were obtained from the biopsy sample. The purpose was to detect quickly, by means of its weak 30-kev gamma ray, the possible presence of Ac^{227}, which, because of its much longer half-life, would have made the nature of the accident considerably more serious. Fortunately, the complete gamma spectrum of the specimen, taken from 15 to 400 kev, disclosed no 30-kev photopeak, and subsequent chemical analysis for actinium showed, at most, a few ppm of actinium activity relative to thorium. The spectral data obtained on the specimen proved helpful also in determining the relative amounts of Th^{227} and Ra^{223} present therein. This determination consisted in running as a standard a sealed Th^{227} solution, of known content, immediately following separation and for several days thereafter, each run being made over the same portion of the spectrum for which data existed in the case of the biopsy sample. Comparison of the biopsy spectrum with that of the solution led directly to the estimate of absolute activity and of physical equilibrium present in the tissue specimen at the time of removal. The validity of this procedure rests upon the fact that the mass of tissue removed was small, and that it was sealed in a soft glass vial identical to that containing the standardized Th^{227} solution. Thus, similar con-

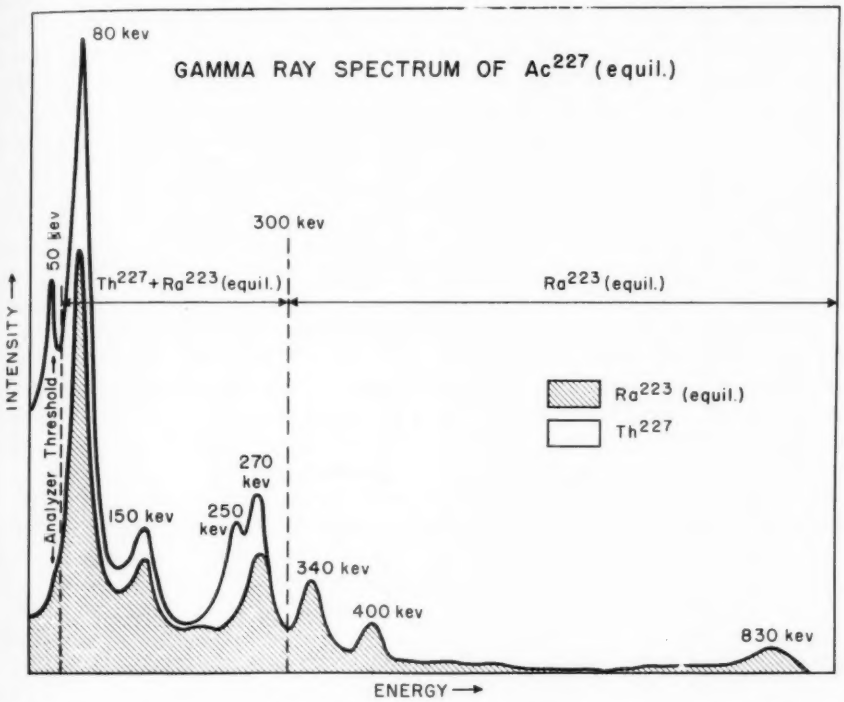

Fig. 1. Gamma ray spectrum of equilibrated Ac^{227}. The shaded area represents Ra^{223} in equilibrium with its daughters; the open area is due to Th^{227} alone.

[3] The bias and band setting used allowed detection of all gamma rays of energy greater than 70 kev.

ditions for scattering and absorption prevailed in both instances.

The results showed that the biopsy specimen contained a three-and-one-half day growth of Ra^{223} at the time of removal rather than the six-day growth expected from undisturbed radioactive disintegration. The difference is to be attributed to the greater transport rate of radium from the wound.

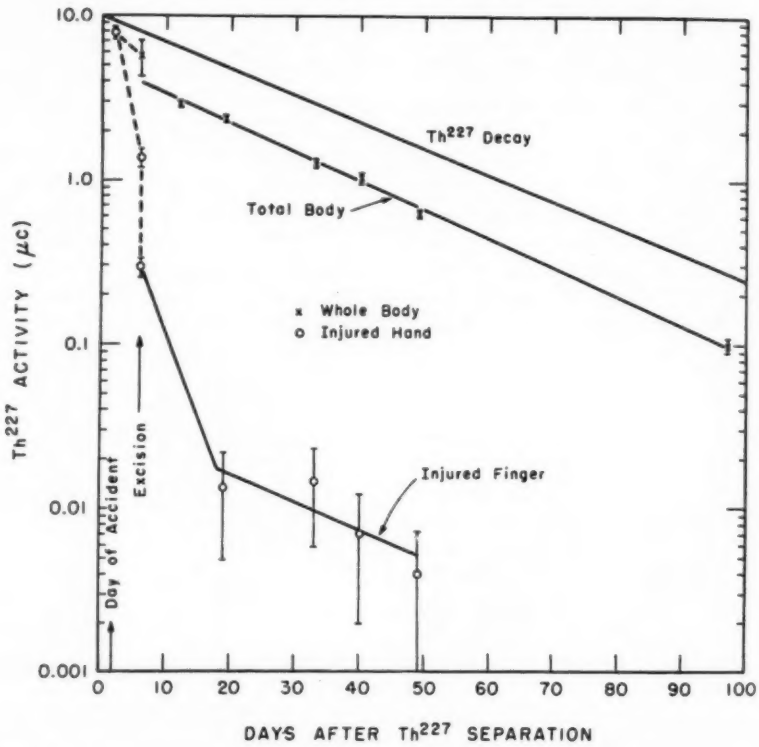

Fig. 2. Time relationship of the thorium activity present in the injured finger and in the body as a whole.

By spectral analysis analogous to that used for the biopsy sample, it was possible to estimate subsequently both the Th^{227} and the Ra^{223} remaining in the finger. In view of the rapid removal of activity from the puncture site, care was taken to subtract, as background, the readings of the uninjured hand from those of the injured one, while keeping identical subject-counter position.

This precaution was not taken at the time of the first (non-spectral) preoperative and postoperative finger readings; the small background correction found afterward would indicate, however, that no great error was introduced by this omission since, percentage-wise, they would undoubtedly have been smaller. The absolute values involved, therefore, are to be considered fairly accurate in view of the fact that (*a*) the difference between these first two readings was evaluated in absolute terms by careful measurements on the biopsy specimen, and (*b*) the gamma spectra in question were identical.

The Th^{227} activities in the injured hand are shown in Figure 2, and, with those of Ra^{223}, are tabulated in Table IV.

ESTIMATES OF BODY TH^{227} AND RA^{223}

The readings of total-body gamma-ray activity were taken immediately before

and after excision of the wound with the same apparatus used to investigate the activity of the latter. The first of these was taken with the patient placed in the "standard chair position" and the other at the "standard distance of one meter." A detailed description of this procedure has been published elsewhere (2). It must be realized that this method is applicable only in the presence of a single radioelement in equilibrium with its daughters and that, therefore, some uncertainty remains about the validity of the body estimate thus obtained. As a rough approximation it was assumed that the radioactive equilibrium extant at four days in the biopsy specimen was representative of that in the body as a whole. Although this assumption seems to be justified by data taken at later times (*vide infra*), there is no real proof of its validity at the time in question.

Such ambiguity does not exist in subsequent body readings, when the gamma-ray spectrum of the radiation emitted by the body was recorded with a 24-channel analyzer covering a pulse-height band of 60 to 750 kev. With the spectral information obtained, it was possible to evaluate independently the activity in the body of both Th^{227} and Ra^{223}. The choice of 60 kev as a lower cutoff was unfortunate, in that the Th^{227} gamma spectrum contains a rather intense line at 50 kev and no Ra^{223} line exists below 80 kev.[4] The spectrum of both elements in equilibrium is shown in Figure 1, with the sources placed in air. From its features it is evident that by far the simplest method of determining Ra^{223} relative to Th^{227} would have been to compare the intensities of the Th 50-kev peak to the Ra^{223} peak at 80 kev, with due allowance for the pulses engendered by scattered gamma radiation of higher energy.

An alternative method of lower sensitivity presented itself, however, since Th^{227} emits no gamma rays of energy greater than 300 kev, while Ra^{223} and its daughters emit some radiation above this energy. Therefore, all radiation above this threshold may be assumed to come from Ra^{223} and its decay products. By counting separately an equilibrated Ra^{223} source, it is possible to determine what fraction of the total count from this isotope falls in the 60- to 300-kev range; thus, in the presence of an unknown mixture of Th^{227} and Ra^{223}, it is possible to "peel" off the counts due to Ra^{223} in that interval from the intensity registered above 300 kev and to compute by simple difference those due to Th^{227} alone.

To account for absorption or scattering *in vivo*, the procedure indicated above was implemented with Ra^{223} and Th^{227} sources placed at various depths in a Presdwood phantom of 20 × 20 × 30 cm. which had proved satisfactory in an earlier study (2). Experimentally, it was noted that the fractions of Ra^{223} counts above and below 300 kev remained approximately constant below the first centimeter of depth; hence, the effective depth of Ra^{223} deposition should not have seriously affected the determination of the relative amounts of Th^{227} and Ra^{223} activity.

Sources of both equilibrated Ra^{223} and Th^{227} were calibrated by alpha counting and the activities expressed in microcuries. These sources were, in turn, measured with the scintillation counter, and the number of gamma counts per minute per microcurie was obtained in both pulse-height bands. This was done both in air (1 meter source-to-counter distance) and at various depths in the phantom, the distal surface of which was placed at 1 meter from the counter, as has been described elsewhere (2).

For measuring the total-body activity, the patient was placed in an arc of 1 meter radius. The total count was then analyzed for the μc values of Th^{227} and Ra^{223} present, assuming a 5-cm. depth of isotope deposition.

As an example, the calculation for body burden on the twelfth day was carried through as follows.

Scintillation counter measurement of the patient gave:

[4] This fact was not realized at first, because no thoroughly separated standards of Th^{227} and Ra^{223} were then available for scrutiny with our apparatus.

TABLE II: TOTAL-BODY ACTIVITY AFTER EXCISION*

Days†	μc Th^{227}	μc Ra^{223}	In vivo	Ra/Th Activity Ratio Calculated‡	Physical§
6	(5.64 ± 1.40)	(0.93 ± 0.23)	(0.165)	0.09	0.21
12	2.92 ± 0.07	0.38 ± 0.05	0.130	0.11	0.39
19	2.36 ± 0.06	0.26 ± 0.05	0.110	0.12	0.56
33	1.28 ± 0.08	0.18 ± 0.05	0.141	0.14	0.85
40	1.03 ± 0.08	0.17 ± 0.05	0.165	0.15	0.96
49	0.62 ± 0.04	0.10 ± 0.05	0.161	0.15	1.06
97	0.10 ± 0.01	0.02 ± 0.05	0.200	0.16	1.37

* Values in parentheses refer to body burdens which would have obtained *in vivo* if the proportion of Ra^{223} and Th^{227} in the excised tissue were representative of the partition existing in the body. Errors indicated above refer only to standard errors in counting. The accident occurred two days after Th^{227} separation.
† Days after Th^{227} separation (6-9-54).
‡ Ratio calculated on the assumption the Ra^{223} produced by Th^{227} is retained according to the formula $0.3t^{-0.7}$.
§ Ratio expected from radioactive decay only.

$N_1 = 501\ c/m$ and $N_2 = 489\ c/m$ yielding $\sqrt{N_1 N_2} = 495\ c/m$.

Of these, 17.5 c/m were of energy greater than 300 kev. In the phantom 14.2 per cent of the counts from the Ra^{223} standard were above 300 kev; hence, assuming identical Ra^{223} spectra in both media, one obtains for the patient:

Ra^{223} activity $= 17.5/.142 = 123\ c/m.$
Th^{227} activity $= 495 - 123 = 372\ c/m.$

At this point the calculations of Marinelli *et al.* (2) apply unmodified. Hence,

$$Th^{227}\text{ body burden} = \frac{372\ e^{-\mu' d/2}}{121\ e^{-\mu_1 d}}\ [K(x)K(d-x)]^{1/2}$$

where

$$\frac{e^{-\mu' d/2}}{e^{-\mu_1 d}}\ [K(x)K(d-x)]^{1/2} = 0.95 \text{ for } Th^{227}$$

and $N_4(\mathrm{Th}) = 121\ c/m/\mu c$ at 1 meter in air.

Thus

$$Th^{227}\text{ body burden} = 372 \times 0.95/121 = 2.92\ \mu c.$$

Similarly

$$Ra^{223}\text{ body burden} = \frac{123\ e^{-\mu' d/2}}{313\ e^{-\mu_1 d}}\ [K(x)K(d-x)]^{1/2}$$

where

$$\frac{e^{-\mu' d/2}}{e^{-\mu_1 d}}\ [K(x)K(d-x)]^{1/2} = 0.96 \text{ for } Ra^{223}$$

and $N_4(\mathrm{Ra}) = 313\ c/m/\mu c$ at 1 meter in air.

So that

$$Ra^{223}\text{ body burden} = 123 \times 0.96/313 = .37\ \mu c.$$

In these calculations the significance of N_1, N_2, N_4, μ', μ_1, and $[K(x)K(d-x)]^{1/2}$ are as defined in the paper by Marinelli *et al.*, cited above (2). They were determined separately for the Th^{227} and Ra^{223} source. The Th^{227} body content obtained at different times after the accident is plotted in Figure 2. Values for both Th^{227} and Ra^{223} are shown in Table II for purposes of comparison.

The opportunity of checking independently the accuracy of these estimates by measurement of the activity excreted was missed by the failure to assess carefully the highest rates of the latter in the first days following the accident. It should be recalled, however, that independent proof of the validity of this approach has been obtained both in man and in animals (2–4). In the present study, measurement of Th^{227} and Ra^{223} gamma radiation from the body merely shows negligible excretion of the former and partial equilibrium of the latter. Within the rather large experimental errors, this is in accord with the bioassay data on excreta. The latter, calculated from incomplete samples on the basis of 1,250 c.c. of urine and 25 gm. dry weight of feces per day, are shown in Table III.

A word should be said concerning apparent retention of Ra^{223} in bony areas of the body. On the same days that readings were taken on the right and left hands, similar readings were taken at a short distance from the head, knees, stomach, and liver. The Ra/Th ratio for

each site was computed, and normalized by dividing it by the ratio found in the area of the liver on the same day. There was a consistent indication of increased Ra/Th ratio in regions of relatively higher bone content. These findings are in accord with the bone-seeking properties of radium but they are not definitive enough to permit conclusions on the relative localization and mobility of radium and thorium in various tissues.

DISCUSSION

Gross Metabolism of Th^{227}: The scarcity in the literature of experimental data dealing with the transport and distribution of thorium compounds in animals precludes quantitative comparison with the human data obtained here. Chemically, thorium chloride is classed as being very soluble and thus falls into the same category as thorium nitrate and thorium sulfate. Experiments reported on animals reveal that both the sulfate (5) and nitrate (6) are retained effectively if administered intravenously, but that they are easily eliminated when ingested or inhaled (5, 7, 8). Moreover, a high and persistent retention occurs at the site of injection when they are given intramuscularly or subcutaneously (5).

$ThCl_4$, on the other hand, given intramuscularly to rats, has been reported by Hamilton (9) to display considerable mobility, since only 21.4 and 14.4 per cent of the dose remained at the injection site at the end of four and eight days, respectively. Our observations (Fig. 2) show comparable retention in the neighborhood of the injection site on the fourth day after the accident. Part of the observed Th^{227} mobility in our case, however, may be due to the irrigation of the wound with CaEDTA shortly after the accident. Comparison with Hamilton's data at eight days is futile because of the variables introduced by surgical intervention and by intravenous administration of CaEDTA. Suffice it to say, that considerable Th^{227} transport (~90 per cent) from the site of the wound took place in the two weeks following excision (Fig. 2). This is definitely greater than the fraction observed in rats from the fourth to the eighth day and may well be due to the factors mentioned above.

TABLE III: Th^{227} AND Ra^{223} EXCRETION DATA*

Th^{227}		Ra^{223}	
Day†	μc	Day†	μc
	Urinary Excretion		
2	2.9×10^{-1}		
6	2.2×10^{-2}		
7	2.0×10^{-2}	7	6.9×10^{-3}
10	3.1×10^{-3}	10	5.6×10^{-3}
13	3.9×10^{-3}	13	8.4×10^{-3}
14	1.1×10^{-3}	14	3.1×10^{-3}
27	5.6×10^{-4}	27	2.3×10^{-3}
48	1.2×10^{-4}	48	2.1×10^{-3}
70	4.7×10^{-5}	70	2.2×10^{-4}
159	1.5×10^{-6}	159	2.6×10^{-5}
221	1.9×10^{-7}	221	2.5×10^{-6}
	Fecal Excretion		
7	4.8×10^{-3}	7	1.9×10^{-1}
36	2.0×10^{-4}	36	2.4×10^{-2}
48	1.1×10^{-4}	48	6.9×10^{-3}
72	1.7×10^{-4}	72	2.4×10^{-3}
221	1.2×10^{-6}		

* Based on daily outputs of 1,250 c.c. of urine and 25 gm. dry feces.
† Days after Th^{227} separation.

Gross Metabolism of Total Body Ra^{223} Growing from the Decay of Th^{227}: In view of the additional variables introduced by the injection of CaEDTA, and the paucity of excretion data, it is perhaps unwise to compare the elimination rates of Ra^{226}, following injection or inhalation (3, 10) in man, to that of Ra^{223} from the sites of Th^{227} deposition, as is presently the case. Certain observations are nevertheless in order: Analysis of excreta shows that, after the thirty-sixth day, a considerable fraction (~40 per cent) of the estimated radium burden is excreted daily. Also it can be seen from Table II that the Ra/Th activity ratio in the body is of the order of 10 to 20 per cent, much lower than the value expected from the undisturbed growth of Ra^{223} and Th^{227}. These observations, effectively supported by the independent measurements of excreta, clearly demonstrate the preferential excretion of radium over thorium. Calculations reported in detail elsewhere (11) show that, within the rather large experimental errors in our data, the latter are consistent with a

TABLE IV: SUMMARY OF THE ACTIVITY IN THE INJURED HAND

Days*	μc Th^{227}	μc Ra^{223}	Ra/Th Activity Ratio		
			In vivo	Physical	In vivo / Physical
6†	1.4 ± 0.2	0.23 ± 0.03	0.168	0.21	0.82
6	$2.9 \pm 0.4 \times 10^{-1}$	$4.9 \pm 0.66 \times 10^{-2}$	0.168	0.21	0.82
19	$1.3 \pm 0.8 \times 10^{-2}$	$0.05 \pm 0.78 \times 10^{-2}$	0.004	0.56	0.01
33	$1.4 \pm 0.8 \times 10^{-2}$	$2.2 \pm 1.0 \times 10^{-3}$	0.152	0.85	0.18
40	$7.0 \pm 5.0 \times 10^{-3}$	$1.0 \pm 0.8 \times 10^{-3}$	0.136	0.96	0.14
49	$4.0 \pm 3.3 \times 10^{-3}$	$0.43 \pm 0.52 \times 10^{-3}$	0.109	1.06	0.10

* Days after Th^{227} separation.
† Reading before excision. Other readings taken after excision.

Ra retention described by the following expression:

$$\text{Retention} = 0.3\, t^{-0.7}$$

where t is expressed in days. These constants are different from the averages obtained by Norris *et al.* (10) on a series of human beings intravenously injected but are very close to those obtained by Stehney (12) on a group drinking potable water of low natural radium content for many years. These findings are rather perplexing because, in our case, the constants apply to radium produced at the sites of thorium deposition in the body and to its release therefrom in the general circulation. Similar experiments reported by Van Dilla, *et al.* (13, 14) on beagles injected with Th^{228} indicate that the Ra^{224} daughter behaves as though it were continually injected intravenously. If this were also the case in man, our constants should be similar to those of Norris; since they are not, we must temporarily conclude that either the findings in dogs do not apply to man or that, most likely, the discrepancy is due to metabolic variation in individuals. Further observations on larger numbers of human subjects are needed to decide the issue. Finally, it should be understood at this point that retention of radium *in vivo* is a function of both radioactive decay and metabolic elimination; hence, uniqueness of the latter does not imply a unique equilibrium ratio in the various radioactive chains involving the same elements. The radioactive half-life must be expected to play a predominant role in many instances.

Residual Activity in the Injured Finger: Since, in the case under consideration, all of the Th^{227} is assumed to have entered the body *via* the puncture, all activity must have been present initially at the wound site. The minimum value for this figure was obtained by taking the total-body Th^{227} reading on the sixth day, before excision, and correcting for decay back to the second day, *i.e.*, the day of the accident. This is shown in Figure 2.

The Ra/Th ratio at various times thereafter is indicated in Table IV. Its temporary but marked decrease within the six- to nineteen-day interval cannot be attributed to the use of CaEDTA, since this chemical has much higher affinity for thorium than for radium. The decrease may instead reflect the possibility that, during the handling of a traumatic process, radium is more effectively mobilized than thorium. This intriguing phenomenon, if true, may have consequences of practical importance and hence seems to be worthy of further investigation. On the other hand, the possibility of a spurious result on the nineteenth day cannot be excluded, since the low radium value may have been the result of undetected failure in one or more relevant channels of the multichannel analyzer. This possibility, however, is to be excluded in the case of the other readings; thus, the radium partition value, as carefully measured in the biopsy sample, may confidently be applied to the wound-site readings on the sixth day, and the hand readings, from the thirty-third day on, are too consistent to reflect erratic misbehavior of the apparatus.

No attempt was made to assess the dosimetric aspect of this case since detailed data on localization of deposits are lacking.

Many of the shortcomings of this study are inherent in the accidental aspects of the contamination. They could perhaps be avoided in other instances if complete control of the patient were implemented by hospitalization soon after an accident, and by conscientious collection of all excreta; arrangements should then be made for long-term use of low-level scintillation spectrometers. The effort required would be well rewarded by the information gained.

SUMMARY

As a result of an accidental puncture with forceps contaminated with $Th^{227}Cl_4$, a few microcuries of the element gained interior access to the body of a laboratory worker, a woman thirty-five years of age. Clinical management and radioactivity studies instituted are described in detail. A single intravenous injection of CaEDTA on the fourth day increased the urinary excretion of thorium but did not significantly reduce the body burden. Spectroscopic investigation of the gamma radiation *in vivo* and excretion data definitely demonstrate that (*a*) thorium in the form of a chloride is readily removed from the puncture, (*b*) the Ra^{223} daughter is removed preferentially from the wound, (*c*) thorium is slowly eliminated in the excreta, and (*d*) Ra^{223} produced in various parts of the body by the decay of Th^{227} is retained in quantity roughly consistent with the equation $0.3t^{-0.7}$ where t is the time in days.

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REFERENCES

1. HAGEMAN, F. T.: The Chemistry of Actinium, Chapter 2 in Actinide Elements, IV Vol. 14A, edited by G. T. Seaborg and J. J. Katz. New York, McGraw-Hill Book Co., Inc., 1954, pp. 27–28.
2. MARINELLI, L. D., MILLER, C. E., GUSTAFSON, P. F., AND ROWLAND, R. E.: The Quantitative Determination of Gamma-Ray Emitting Elements in Living Persons. Am. J. Roentgenol. **73:** 661–671, April 1955.
3. MARINELLI, L. D., NORRIS, W. P., GUSTAFSON, P. F., AND SPECKMAN, T. W.: Transport of Radium Sulfate from the Lung and Its Elimination from the Human Body Following Single Accidental Exposures. Radiology **61:** 903–914, December 1953.
4. GUSTAFSON, P. F., AND MARINELLI, L. D.: A Spectrometric Method for the Study of Radon Partition in Radium-Burdened Animals. Radiology **65:** 90–95, July 1955.
5. SCOTT, J. K., NEUMAN, W. F., AND BONNER, J. F.: The Distribution and Excretion of Thorium Sulfate. J. Pharmacol. & Exper. Therap. **106:** 286–290, November 1952.
6. BLAIR, H. A.: University of Rochester, M-2012, p. 39, December 1947.
7. SALERNO, P. R., AND MATTIS, P. A.: Absorption and Distribution of Thorium Nitrate in the Rat. J. Pharmacol. & Exper. Therap. **101:** 31, January 1951. (Abstract)
8. MATTIS, P. A.: Western Reserve University, NYO-1607, p. 29, July 28, 1950.
9. HAMILTON, J. G.: Metallurgical Laboratory, Radiation Laboratory, and National Cancer Institute, CN3397, p. 14, Jan. 23, 1946.
10. NORRIS, W. P., SPECKMAN, T. W., AND GUSTAFSON, P. F.: Studies of the Metabolism of Radium in Man. Am. J. Roentgenol. **73:** 785–802, May 1955.
11. GUSTAFSON, P. F., AND MARINELLI, L. D.: Calculations Pertaining to Radium Produced in Vivo from a Thorium Parent. Argonne National Laboratory, ANL-5679, January 1957; ANL-5689, in press.
12. STEHNEY, A. F., AND LUCAS, H. F., JR.: Studies on the Radium Content of Humans Arising from the Natural Radium of Their Environment. Peaceful Uses of Atomic Energy. Proceedings of the International Conference in Geneva, August 1955. Vol. 11, Biological Effects of Radiation. New York, United Nations, 1956 pp. 49–54.
13. VAN DILLA, M. A., AND STOVER, B. J.: On the Role of Radiothorium (Th^{228}) in Radium Poisoning. Radiology **66:** 400–401, March 1956.
14. VAN DILLA, M. A., STOVER, B. J., AND ARNOLD, J. S.: On the Retention and Translocation of Ra^{224} (ThX) in Dogs. Am. J. Roentgenol. In press.
15. HOLLANDER, J. M., PERLMAN, I., AND SEABORG, G. T.: Table of Isotopes. Rev. Modern Physics **25:** 469–651, April 1953.

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(*Pro le summario in interlingua, vider le pagina sequente*)

SUMMARIO IN INTERLINGUA

Un Caso de Punction Accidental Contaminate con Th^{227}: Studios in Re Elimination e Activitate Residue in le Corpore

In consequentia de un punction accidental con un forcipe contaminate per $Th^{227}Cl_4$, alicun microcuries del elemento trovava accesso al interior del corpore de un assistente de laboratorio, un femina de trenta-cinque annos de etate. Es describite in detalio le regime clinic e le studios de radioactivitate que esseva instituite. Un injection unic de CaEDTA le quarte die post le accidente augmentava le excretion urinari sed non reduceva significativemente le carga del corpore. Investigationes spectroscopic del radiation gamma in vivo e datos excretori demonstra definitemente que (a) thorium in le forma de un chloruro es facilemente abferite ab le punction, (b) le descendente Ra^{223} es abferite preferentialmente ab le vulnere, (c) thorium es lentemente eliminate in le excretos, e (d) Ra^{223} producite in varie partes del corpore per le disintegration de Th^{227} es retenite in quantitates grossiermente de accordo con le equation $0{,}3t^{-0{,}7}$, ubi t es le tempore in dies.

Physical Measurements on a 4-MEV Linear Accelerator[1]

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THE MEASUREMENTS to be described here were made on a travelling-wave linear accelerator manufactured by Metropolitan-Vickers Co., Ltd. In this machine an electro-magnetic wave with an axial component of electric field is directed along a wave-guide so that electrons injected into the guide may have their energy increased as they move along with the wave. In order that the phase-velocity of the wave may be reduced to the velocity of the electrons, corrugations have to be made in the wall of the wave-guide. Suitable dimensioning of these corrugations ensures that the wave continues to accelerate the electrons as they increase from their initial energy of 50 kev till they strike the 2-mm.-thick transmission-type gold target with a final energy of 4 MEV, attained after travelling a distance of 1 meter. The waves, with a frequency of approximately 3,000 Mc/S, are generated by a magnetron of 2 MW peak power operating with a pulse length of approximately 2 microseconds and a repetition rate of 350 pulses per second. Under these conditions, with a beam-flattening filter which gives a reasonably uniform field 30 cm. wide at 1 meter from the target, a dose rate of over 100 r per minute, measured in air, is obtained at that distance.

Two parallel plate ionisation chambers are incorporated in the x-ray head, one being connected to a dose-rate meter and the other to a dosemeter in the control desk. Provision is made for terminating the exposure after a pre-set dose is reached.

The equipment has been fully described by Miller and Flanders (1).

The layout of the treatment, control, and apparatus rooms in any particular department is usually dictated by local geography and requirements, and will not be described. The treatment room is surrounded by concrete walls 2 feet 6 inches thick, except for one wall on which the direct beam of the x-rays may be incident, which is 5 feet thick. A direct viewing window is set in one wall above the control desk. This window is constructed from eighteen sheets of $1^1/_2$-inch plate glass set in a bronze casting, the space between the sheets being filled with liquid paraffin to minimise internal reflection. Cerium oxide is incorporated in nine of the sheets nearest the treatment room to prevent discolouration from radiation. The effective area of the window is 21 × 16 inches.

The design of the treatment couch is based on principles described by Flanders and Newbery (2), *i.e.*, the vertical axis of rotation of the couch passes through a point 1 meter from the target, at which the x-ray beam axis and the horizontal axis of rotation of the accelerator gantry intersect. The x-ray beam can be swung from a position 20° beyond the vertical on one side to 120° beyond the vertical on the opposite side. To allow the gantry to reach this latter position, a section of the treatment room floor can be lowered.

PROTECTION MEASUREMENTS

A protection survey was made with the machine operating so as to give a dose rate of 100 rads/min. at 1 cm. depth in a water phantom with its surface 1 meter from the target, with a 20 × 20-cm. field. A Baldwin Instrument Co. Ionex equipment was used with a 600-c.c. ionisation chamber, which was calibrated with a radium source. For any position of the beam, the dose rates at all places where members of the staff could be present were found to be less than 3.5×10^{-6} rads/min; *i.e.*, approximately 0.025 of the maximum per-

[1]From the Physics Department, Western General Hospital, Edinburgh, Scotland. Accepted for publication in September 1956.

missible level of 0.3 rads/35 hr. The measurements were in fairly close agreement with expected values calculated by Flanders (3).

The design of the x-ray head was specified by Flanders to be such that the radiation transmitted by the main shielding would be about 0.03 per cent of that in the main beam. A similar contribution was to be expected from radiation scattered through 30° by the various filters in the direct beam. The beam-defining diaphragms of 4-inch lead are designed to reduce the transmitted intensity to 1.4 per cent through a single thickness and 0.03 per cent through a double thickness of 8 inches when set for small field areas. The values obtained by measurement will depend on the area of diaphragm irradiated. With the smallest possible field size, the transmission through the double thickness was found to be 0.05 per cent and that through a 4-inch lead block in front of the aperture 0.43 per cent. These figures are of importance in connection with integral doses received by patients under treatment.

Between treatments the machine is normally left in the "ready" position, in which the electron gun filament is energised and the R.F. power switched off. However, it is sometimes necessary during maintenance operations to enter the treatment room when the R. F. power is on, although the gun filament is off. Under these latter conditions there is an induced potential of between 1 and 2 volts across the ends of the filament, and it is possible for some electron emission to take place. The dose rate in the beam at 1 meter from the target arising in this case is not more than the maximum permissible value.

BEAM SYMMETRY

In order to produce a symmetrical x-ray distribution over the irradiated field, the electron beam must be maintained coaxial with the x-ray collimator. This is ensured by accurate stabilisation of the supply to the focussing and deflector coils around the corrugated wave guide after the initial adjustment of coil, positions, and current

Before investigation of beam symmetry, it was necessary to ensure that the reference frame for measurements was in a known relationship to the axis of the x-ray collimator and beam-defining system. The optical system for illumination of the irradiated area was first adjusted to give coincidence of illuminated and irradiated areas, by the use of a photographic film technique. A Perspex diaphragm inscribed with two lines coincident with the axes of the field defined by the diaphragms was fitted to the end of the x-ray head 64 cm. from the target and was used to set up the apparatus carrying the ionisation chamber, in the manner shown in Figure 1. Confirmation of correct alignment was obtained as follows:

Ionisation measurements were made at points across the beam, when a wedge filter was fixed in the x-ray head to produce an asymmetrical distribution, for two positions of the head 180° apart. The centre of rotation of the head, and hence the central axis of the beam, was found from the intersection of the two curves of ionisation against chamber position.

Measurements with a thimble chamber were made along the axes of a 20 × 20-cm. field in air. Departures from radial symmetry did not exceed 4 per cent up to 9 cm. from the beam axis. This was felt to be satisfactory for clinical purposes. Such symmetry is particularly important where wedge filters are to be used.

PHYSICAL CHARACTER OF THE BEAM

A build-up curve was measured for the cylindrical ionisation chamber (0.5-mm. Tufnol wall) which was to be employed for many of the x-ray measurements, using close-fitting Perspex caps. The chamber was held with its centre on the beam axis, 1 meter from the target, 8 mm. of Perspex being required for maximum build-up in air. From measurements at various field sizes, with full build-up, it was concluded that an increasing contribution of scattered radiation is received

TABLE I: ABSORPTION CHARACTERISTICS IN LEAD, BRASS, AND "MIX D"

Absorber Material	h.v.l. in Absorber, (cm.)	μ/ρ eff. (cm.²/gm.)	$E_{eff.}$ (MEV)
Lead	1.12	0.0545	1.50
Mix D	12.15	0.0570	1.53
Brass	1.65	0.0495	

by the chamber, amounting to about 3.5 per cent with a 20 × 20-cm. field. The effect of scattered radiation from the beam-defining system is shown by a difference in the dose rate at points outside the main beam in rectangular fields. At such points the dose rate depends on whether a given field dimension is defined by the upper or lower diaphragm; the difference is only about 0.3 per cent of the dose rate at the centre of the field and is clinically unimportant.

Recoil electrons from the beam-defining system were found to make only a small contribution to the dose at a point on the surface of a phantom. Their contribution has been eliminated by the introduction of the Perspex diaphragm at the end of the x-ray head; although the recoil electrons from this Perspex increase the total contribution slightly, this is made independent of diaphragm position at a point bearing a given relationship to a given size of field. The total electronic contribution is now from the intervening air and the Perspex. The effect of recoil electrons on surface dose will be considered later.

Absorption measurements were made on the beam in lead, brass, and "Mix D" (a tissue-equivalent wax) (4), with geometrical conditions such that the ratio of scattered to transmitted photons reaching the detector was less than 0.2 per cent (5). The absorption curves showed only a slight departure from effective homogeneity in all cases. Values of h.v.l., effective mass absorption coefficient, and effective quantum energy, interpolated from values of μ/ρ given by White (6), are shown in Table I.

ISODOSE CURVES

For points not near the penumbra or

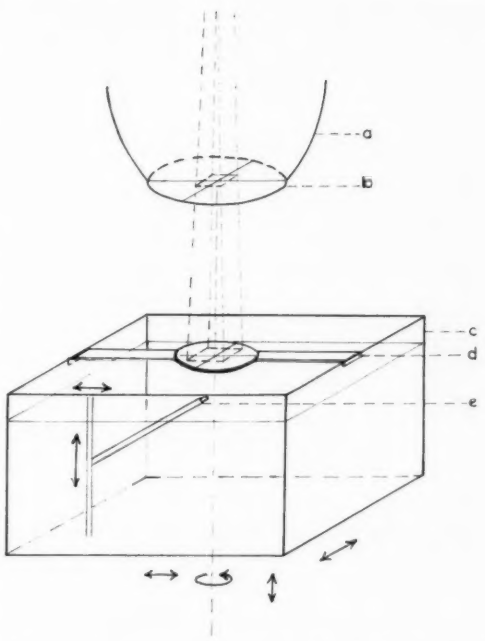


Fig. 1. Arrangement used in alignment of x-ray beam and measuring equipment. *a*. X-ray head. *b*. Perspex diaphragm. *c*. Phantom. *d*. Phantom centre indicator. *e*. Ionisation chamber.

surface, a cylindrical ionisation chamber of air volume 8 mm. long by 6 mm. diameter was used to measure isodose curves, with a vertical x-ray beam in a water phantom, as shown in Figure 1. The chamber was driven by magslips remotely operated by identical magslips geared to indicating scales. Ionisation currents were measured on a Baldwin Ionex equipment, using the dose or dose-rate meters on the machine as monitoring instruments.

The central axis dose near the surface (to 5 cm. depth) was obtained by using a flat chamber having a front wall of polythene 0.1 mm. thick, an electrode spacing of 1 mm., a collector electrode diameter of 1 cm., and an air-space diameter of 3 cm. This geometry was thought to be adequate to eliminate absorption in the chamber structure of electrons ejected at large angles from air near the chamber surface (7). The chamber was embedded with its surface flush with the top of a "Mix D" phantom. A thin-based Perspex

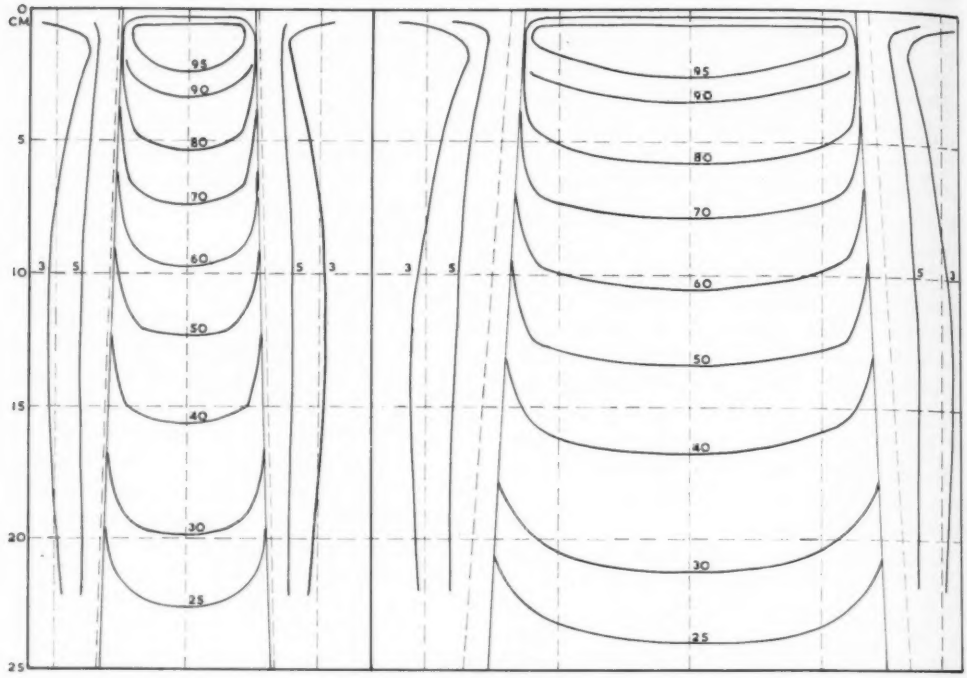


Fig. 2. Isodose curves: 4 MEV, 90 cm. F.S.D., fields of 6 × 8 cm. (left) and 8 × 15 cm. (right).

tank was placed on top, and water was added to give the required thickness; a correction was applied for changes in F.S.D. so introduced. Ionisation currents were measured on an Ekco Vibrating Reed Electrometer, mean values of those obtained with opposite polarity being used. The depth dose curves obtained with the two systems agreed well.

For doses in the penumbral region, even an ionisation chamber of much smaller dimensions than that used will not give a true picture of dose distribution. There is no virtue in producing such distributions for clinical work, but it was decided to limit the indicated figures to 80 per cent of the central axis dose at the same depth. The width of the beam at this 80 per cent value was found from photographic film measurements. Ilford N5/50 film was covered by black paper, laid between sheets of a "Mix D" phantom, and exposed to radiation with the central axis of the beam in the plane of the film. The film was calibrated by exposing sheets at the depth of electronic equilibrium (1 cm.) in the phantom to known doses of radiation. Bearing in mind the limitations of film dosimetry pointed out by Greening (8) and Mathewson (9), it was felt that the resulting positions of the 80 per cent values obtained in this way are reasonably accurate. They were found to lie on a straight line, which can be taken as the inner edge of the penumbra. Beyond this line the dose fell off extremely rapidly to the region of side-scattered radiation, where ionisation measurements could again be made.

It had been decided to operate the equipment for most clinical purposes with a fixed target-tumour distance of 1 meter. This causes the F.S.D. to vary from 80 to 95 cm. in typical treatments. Central axis depth-dose measurements were made at F.S.D.'s from 80 to 100 cm. for field sizes from 4 × 4 cm. to 20 × 20 cm. These field sizes are at 1 meter from the

target and are indicated on scales attached to the beam-defining system. Taking depth doses at 90 cm. F.S.D. as standard, the differences at 85 and 95 cm. F.S.D. are less than 1 per cent of the maximum for all depths up to 15 cm., and are in agreement with values calculated from the inverse-square-law formula, as has been found by Greene and Tranter (10). Only in exceptional circumstances is the F.S.D. less than 85 cm., and, in fact, the differences at 80 cm. F.S.D. are less than 2.5 per cent. In view of these findings, isodose curves were measured at 90 cm. F.S.D., and are considered sufficiently accurate for clinical purposes.

Two typical dose distributions are shown in Figure 2, the values being expressed as percentages of the dose at the equilibrium depth on the central axis. From flat chamber measurements this was found to be 1.0 cm. below the surface of the phantom. When the larger cylindrical chamber was used, the depth of the chamber centre for maximum ionisation was found to be 1.3 cm., as would be expected from the chamber dimensions. Slight asymmetry found in practice was ignored in drawing the curves, which are the mean of values on each side of the axis. Outside the main beam near the surface, the isodose curves swing outward, as has been found by Newbery and Bewley (11) for 8-MEV x-rays; this has been shown to arise from recoil electrons. It has been found that isodose curves calculated from central axis depth-dose data by the method of Day (12) are in good agreement with the measured curves. In particular, the contribution to the dose outside the main beam from radiation transmitted through the beam-defining diaphragms is very small.

Central axis depth-dose values are shown in Figure 3, plotted as a function of area of field, for square fields. The figures for zero area were obtained using the measured values for the absorption coefficient of "Mix D." The effect of elongation of field on the depth dose was investigated at depths of 5 and 10 cm. If the results

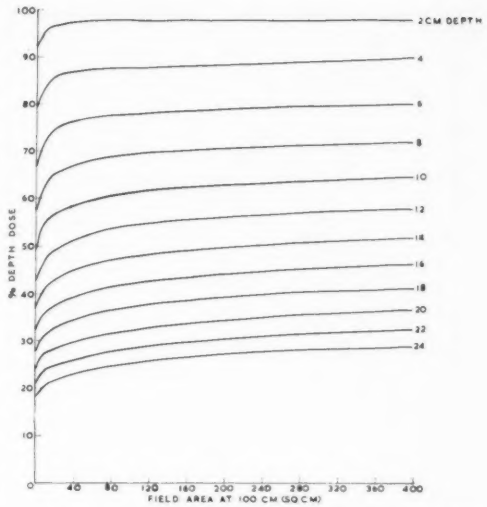


Fig. 3. Variation of central-axis depth-dose values with field area at different depths. 4 MEV., 90 cm. F.S.D.

are expressed in terms of an area-reduction factor (13), this factor appears to decrease markedly with increased elongation, owing to the relatively slow increase of depth dose with area. We have preferred to express the effect in terms of a correction factor to be applied to the square-field depth dose. This factor is constant for all areas at a given depth, as has been found by Wilson and Perry (14) for 2 MEV x-rays. The factor varies linearly with depth for each elongation ratio, so that its value at any depth can be obtained from those given in Table II at 10 cm. depth.

TABLE II: EFFECT OF ELONGATION ON PERCENTAGE DEPTH-DOSE VALUES AT 10 CM.
4 MEV, 90 cm. F.S.D.

Elongation ratio	2	3	4	5
Correction factor	0.991	0.981	0.971	0.959

Isodose curves have also been measured with the x-ray beam at oblique incidence; a typical distribution is shown in Figure 4. Comparison with the corresponding curves for normal incidence shows that the central axis depth doses are identical, as would be expected. The slope of the isodose curves at the central axis corresponds closely with the theoretical value calculated by the

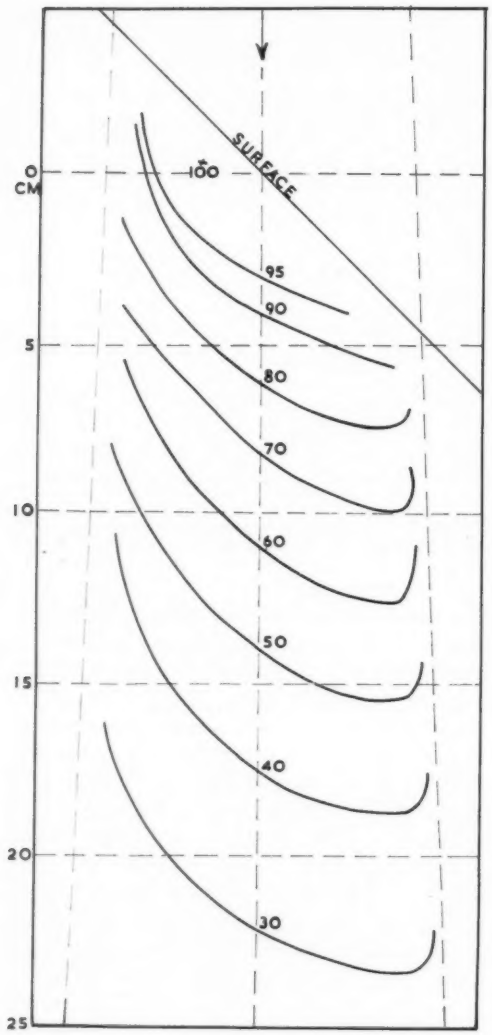


Fig. 4. Isodose curves for 10 × 15-cm. field inclined at 45° to surface of phantom. 4 MEV, 90 cm. F.S.D.

method described in Appendix I. Below the depth of maximum ionisation the depth dose at a point P off the central axis may be obtained by use of the curves for normal incidence in two ways. One (Fig. 5A) is to superimpose the chart on the outline so that the line corresponding to zero depth passes through a point S on the outline and SP is parallel to the central axis of the beam. The actual depth dose is then read from the chart in this position, multiplied by an inverse-square-law correction factor $(F+x)^2/F^2$ as shown. Alternatively, a method which involves no movement of the chart from its normal position (Fig. 5B) may be used In this position the actual depth dose is that read from the chart multiplied by an absorption correction factor, $e^{-\mu x}$. The value of μ is a function of the field size and has been determined from central-axis depth doses corrected for the effect of F.S.D. (15, 16). The depth doses so calculated agree with the values obtained from isodose curves at oblique incidence. Both of these methods give good agreement for all field sizes up to angles of incidence of 45°. Measurements at greater angles have not been made, as they seldom occur in practice. The second method has been preferred for routine use, and a graph of the correction factors required is shown in Figure 6. In practice, it is sufficient to use an average value of effective absorption coefficient for all field sizes, as the correction is a second order one.

SURFACE IONISATION RATIO

From measurements with the flat ionisation chamber, it is possible to derive the surface ionisation ratio (S.I.R.), if the contribution of secondary electrons from the thin front wall to the ionisation measured with no added build-up material is known. This true surface ionisation may be obtained from an extrapolation of a build-up curve using successive thin sheets of polythene. Figure 7 shows the variation of S.I.R. with field size, with and without the Perspex diaphragm in position. As can be seen, the introduction of this diaphragm has only a small effect on S.I.R.

Howarth (17) has described a method of calculating S.I.R. in which no account is taken of the contribution due to back-scattered electrons or recoil electrons arising from subsequent scattering at points below the ionisation volume. Such a calculation has been made assuming an average energy of 1.5 MEV, and the measured values have been corrected to

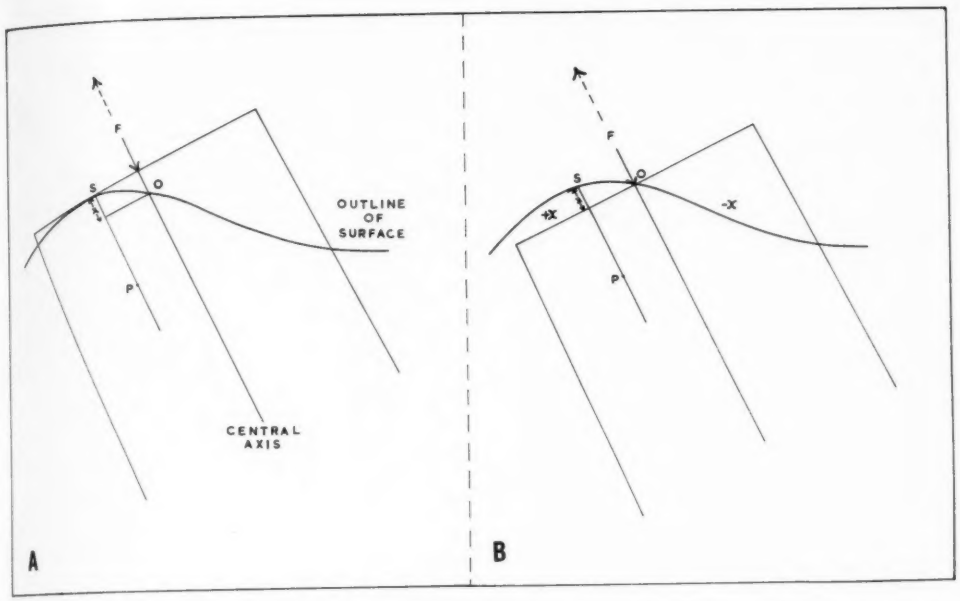


Fig. 5. Methods of determining depth doses in cases of oblique incidence, using normal isodose curves.
A. Depth dose at P = depth dose read from curves $\times (F + x)^2/F^2$.
B. Depth dose at P = depth dose read from curve $\times e^{-\mu x}$.

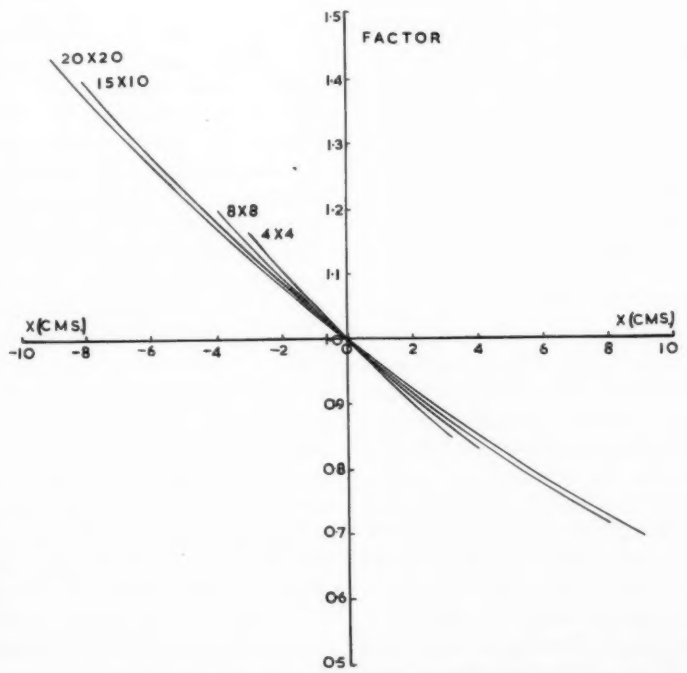
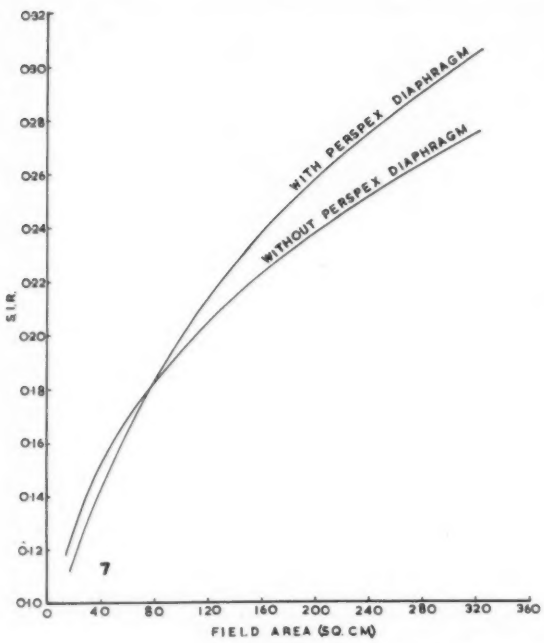


Fig. 6. Correction factors for depth doses in cases of oblique incidence.



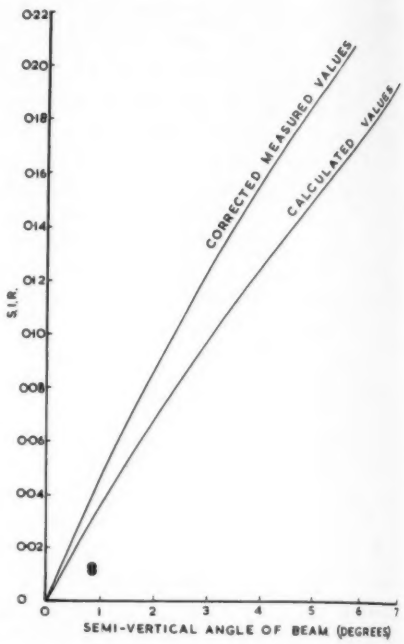


Fig. 7. Variation of surface ionisation ratio with field area.
Fig. 8. Comparison of calculated and corrected measured values of surface ionisation ratio (S.I.R.).

allow for factors not included in the calculations. A comparison between corrected measurements and calculated values is shown in Figure 8. The agreement is satisfactory, in view of the number of assumptions made in the theory. In contrast to the results of Haybittle (18), the experimental values are greater than the calculated values.

DOSE CALIBRATION

The dose delivered to the patient is indicated on a meter on the control desk connected to one of the ionisation chambers in the x-ray head. It was necessary to calibrate this meter in terms of the absorbed dose at a depth of 1 cm. on the axis of the beam in a water phantom with its surface at distances of 80 to 100 cm. from the target for all field sizes (defined at 1 meter). The rad (100 ergs/gm.) was used as the unit of dose. A Baldwin-Farmer substandard dosemeter was used for the calibration. This instrument had been compared with substandard dosemeters in use at other centres in the 2–4 MEV energy range, and a correction factor derived for converting to rads the readings under the above conditions of measurement. Farmer (19) has stated that the performance of this instrument with its associated ionisation chamber agrees with the theory of Boag (20). This has been checked and, in fact, saturation conditions are reached with only about 20 volts applied to the chamber, whereas 180 volts are normally applied. Checks with a Co^{60} source jigged to the chamber have shown that its calibration has remained unaltered for a period of two years.

As a further check on the calibration, the oxidation of ferrous sulphate in air-equilibrated 0.8 N sulphuric acid solution has been used to measure the absorbed energy. This work was done in collaboration with Dr. N. Miller of the University of Edinburgh (21). If values of 15.5 for G, the number of ferric ions produced per 100 ev expended in the solution (22), and

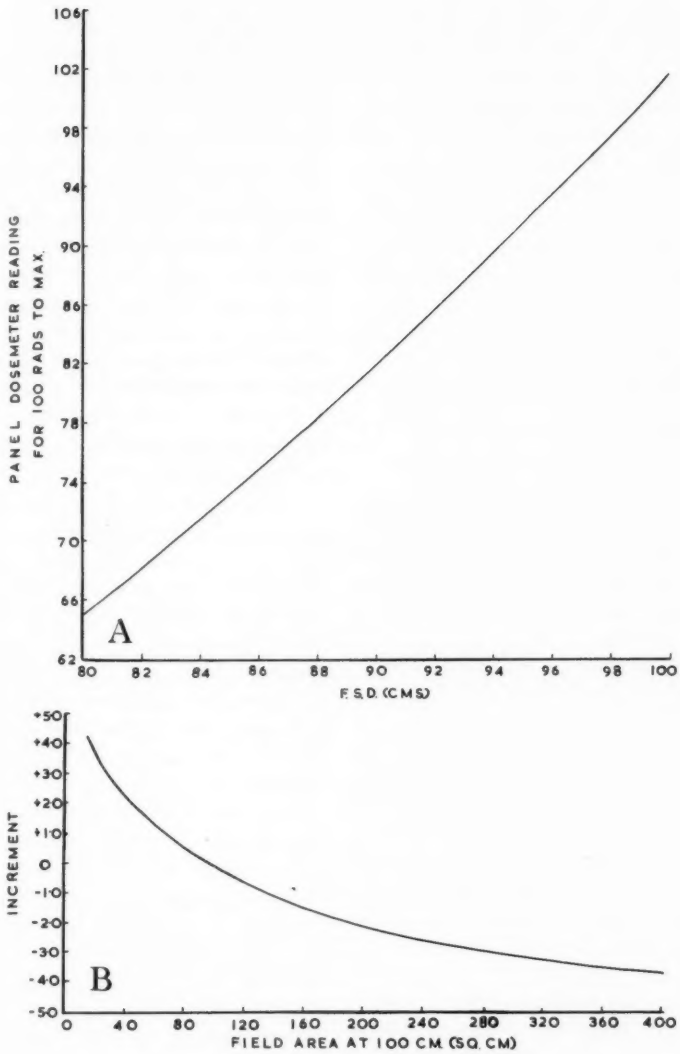


Fig. 9. A. Calibration curve for panel dosemeter, 10 × 10 cm. field.
B. Curve for extending panel dosemeter calibration to all field areas.

34.0 ev for W, the energy required to produce an ion pair by electrons in air, are used, then for measurements performed under identical geometrical conditions the dose estimated chemically is 1.04 ± 0.02 times the dose determined by ionisation measurements.

The control desk dosemeter was calibrated in terms of the reading required to give a dose of 100 rads at a point at a depth of 1 cm. on the beam axis for various F.S.D.'s and field sizes. It was found that this information could be expressed in the form of two curves, one showing the variation of this reading with F.S.D. for a single field size (10 × 10 cm.) and another giving an amount to be added to this reading plotted against field area (Fig. 9).

A routine check of the dosemeter calibration can be performed by use of the

substandard dosemeter with the ionisation chamber covered by the 8-mm. Perspex cap mounted in a jig attached to the x-ray head so that the chamber centre is on the beam axis at 1 meter from the target. In addition to this, it has been thought desirable to check the characteristics of the dosemeter circuit by injecting a standard test voltage into the input. This overcomes any ambiguity of a radiation calibration which may arise from a change of the electron distribution over the target, which would affect the calibration chamber but not the monitoring chamber.

PHYSICAL ASPECTS OF TREATMENT PLANNING

Details of treatment planning will not be included in this paper. In general, however, the increased depth dose permits irradiating deep-seated tumours with fewer fields than with 250-kv therapy, and as a result the preliminary work of planning and setting up is easier. As stated before, a fixed target-tumour distance is used, and it is important, therefore, to know the relevant F.S.D. for each field position, as this determines the control panel dosemeter setting for a given dose to be applied to a point 1 cm. below the skin surface. This distance is obtained from an outline of the patient in the appropriate plane. A front pointer attached to the x-ray head is set so that with the beam in a vertical position and the patient in a prone or supine position, the desired point of intersection of the beam axes in the required field positions is 1 meter from the target.

A coplanar arrangement of field positions can always be found which will give a homogeneous distribution of radiation, provided the tumour has an axis of symmetry coincident with the axis of rotation of the x-ray gantry. If this condition does not apply, it is still possible to effect a homogeneous irradiation of the tumour by angulation of the axis of symmetry of the tumour with respect to the plane in which the beam axis can rotate, until the beam axis becomes perpendicular to the axis of symmetry. This type of situation may occur, for example, with a carcinoma of the oesophagus, in which an approximately cylindrical shape is to be irradiated, the axis of the cylinder being inclined at an angle to the horizontal when the patient is prone or supine, and where it may be impracticable to place the patient in a position in which the tumour axis is horizontal. If the inclination of the beam axis to the vertical is φ, the inclination of the axis of symmetry of the tumour to the horizontal is θ, then the patient must be rotated about a vertical axis through an angle ψ, such that

$$\sin \psi = \tan \theta \cot \varphi$$

The derivation of this relation is shown in Appendix II.

The value of wedge filters for producing suitable dose distributions in x-ray therapy has been well established (23). Work on the design of such filters has been carried out and will be reported in a separate publication. It may be noted that the output of the machine is sufficiently high to allow the reduction to about 60 per cent necessary for production of isodose curves at 45° without having unduly prolonged treatment times.

Integral dose is a factor of some clinical importance in treatment planning. Some approximate calculations have been made from measured isodose curves. In comparison of a 250-kv machine operated at 50 cm. F.S.D. with the 4-MEV unit at 90 cm. F.S.D., the much higher depth dose of the latter compensates for the larger amount of radiation scattered outside the beam in the former, with the result that the integral dose per unit applied dose is the same for both machines at a field size of 10 × 15 cm. The integral dose at 4 MEV, however, is only about 60 per cent of that at 250 kv for a given tumour dose at a depth of 10 cm. This effect is more marked at higher energies, as has been shown by Morrison, Newbery and Deeley (24).

SUMMARY

A brief description of a Metropolitan Vickers 4-MEV linear electron accelerator

is given, together with details of protection and treatment facilities. Measurements relevant to protection of patients and staff are included.

The physical characteristics of the x-ray beam, such as symmetry, contamination, and average energy, are presented. Dose distributions for normal and oblique fields are shown. Methods for deriving depth dose for oblique fields are described. Measurements and calculations of surface ionisation ratio are compared.

A method of dose calibration is described, and a comparison between ionisation and chemical methods of dosimetry is made. Some physical aspects of treatment planning pertinent to the machine are discussed.

ACKNOWLEDGMENTS: The authors are indebted to the following persons for their assistance: Miss C. P. Cameron, for performing many of the calculations during the course of this work, and for the preparation of the diagrams in the paper; Mr. V. G. Cattrell, who was responsible for the photographic measurements of dose; Dr. N. Miller, of the Natural Philosophy Department in the University of Edinburgh, who supplied all facilities for the chemical dosimetry.

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APPENDIX I

Calculation of the Slope of Isodose Curves Produced by Fields at Oblique Incidence

In Figure 10, P_1 and P_2 are points equidistant from the central axis of the beam, at which the doses are to be equal when the beam is inclined at an angle to the normal to the surface of the phantom. If P_1 and P_2 are an infinitesimally small distance apart, than P_1S_1 and P_2S_2, which when produced pass through the focus, may be considered parallel, and the line joining P_1 and P_2 represents part of the required isodose.

If no account is taken of scattered radiation, the ratio (R) of doses at P_2 and P_1 is given by

$$R = \left(\frac{F+d}{F+d+x}\right)^2 \cdot \frac{e^{-\mu(d\,-\,r\tan\theta\,+\,s)}}{e^{-\mu(d\,+\,r\tan\theta)}}$$

where μ is the linear absorption coefficient for the radiation in the medium.

From the geometry

$$2r = x\cot\varphi$$

and hence the expression for R can be written as

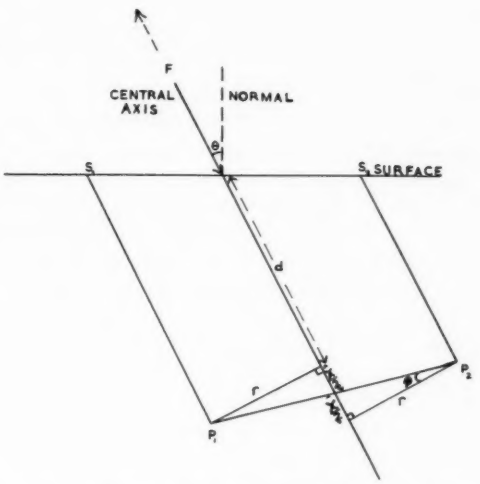

Fig. 10. Diagram showing geometry of field at oblique incidence.

$$R = \left(1 + \frac{x}{F+d}\right)^{-2} \cdot e^{\mu x(\cot\varphi\,\tan\theta\,-1)}$$

As x is infinitesimally small, both terms in the expression for R may be expanded into a series, and terms containing powers of x higher than the first neglected.

Thus

$$R = \left(1 - \frac{2x}{F+d}\right)[1 + \mu x(\cot\varphi\cdot\tan\theta - 1)]$$

$$= 1 + \mu x\,(\cot\varphi\,\tan\theta - 1) - \frac{2x}{F+d}$$

For R equal to unity,

$$\mu x\,(\cot\varphi\cdot\tan\theta - 1) = \frac{2x}{F+d}$$

$$\cot\varphi = \left[\frac{2}{\mu(F+d)} + 1\right]\cot\theta$$

APPENDIX II

Geometry of Treatment Planning for a Tumour Having an Axis of Symmetry Inclined to the Axis of Rotation of the Gantry

OY is the axis of rotation of the x-ray gantry and initially the mid-line of the patient.

OP, in the YZ plane, is the tumour axis.

QO, in the ZX plane, is the central ray of the x-ray beam.

ZOZ' is the axis of the rotation of the treatment couch.

For a given value of θ, it is required to determine the relationship between θ, ψ, and φ as shown in

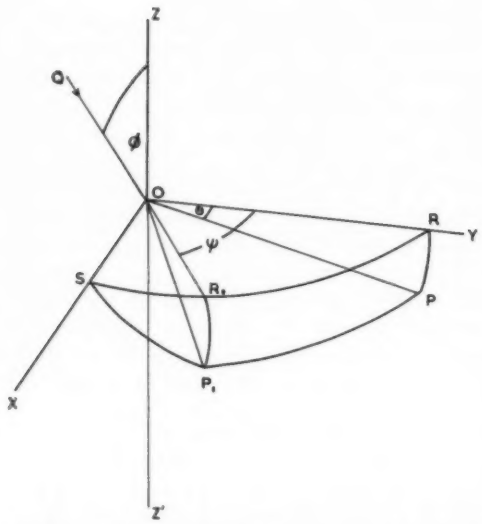

Fig. 11. Diagram showing geometry of inclined tumour axis set-up.

Figure 11 such that QO is perpendicular to OP.

Rotation of the couch through an angle ψ causes R to describe part of a circle on the XY plane while OP generates part of the cone of semivertical angle $(\pi/2) - \theta$. Also, $OR = OP$, so that R, P, R_1, P_1, lie on a sphere, centre O.

Assume that OP_1 is the required position of OP so that angle QOP_1 is a right angle. Let the direction cosines of OQ be l, m, n, and of OP_1 l_1, m_1, n_1. Then $ll_1 + mm_1 + nn_1 = 0$.

Now $l = \sin \phi$, $m = 0$, $n = \cos \varphi$, $n_1 = \cos (\pi/2 + \theta) = -\sin \theta$

$$\therefore l_1 \sin \varphi - \sin \theta \cos \varphi = 0$$

$$l_1 = \sin \theta \cot \varphi$$

In the spherical triangle SR_1P_1, angle $SR_1P_1 = \pi/2$, $SR_1 = (\pi/2) - \psi$, $R_1P_1 = \theta$. By Napier's rule $\cos SP_1 = \cos SR_1 \cdot \cos R_1P_1$; but $\cos SP_1 = l_1$

$$\therefore \sin \theta \cot \varphi = \sin \psi \cos \theta$$

$$\sin \psi = \tan \theta \cot \varphi$$

REFERENCES

1. MILLER, C. W., AND FLANDERS, P. HOWARD: Super-voltage X-ray Therapy and the Linear Accelerator. Metropolitan Vickers Gazette **25:** 119–128, December 1953.

2. FLANDERS, P. HOWARD, AND NEWBERY, G. R.: The Gantry Type of Mounting for High Voltage X-ray Therapy Equipment. Brit. J. Radiol. **23:** 355–357, June 1950.

3. FLANDERS, P. HOWARD: Medical Research Council Memorandum. The X-ray Protection for the 4 MeV Linear Accelerator, 1951. Medical Research Council Drawing. No. C.2753, 1951.

4. JONES, D. E. A., AND RAINE, H. C.: Letter to Editor. Brit. J. Radiol. **22:** 549–550, September 1949.

5. DAVISSON, C. M., AND EVANS, R. D.: Gamma-Ray Absorption Coefficients. Rev. Modern Phys. **24:** 79–107, April 1952.

6. WHITE, G. R.: X-ray Attenuation Coefficients from 10 keV to 100 MeV. National Bureau of Standards Report No. 1003, 1952.

7. HAYBITTLE, J. L.: Ionization Chambers for the Dosimetry of Beta-Ray Applicators. Brit. J. Radiol. **28:** 320–324, June 1955.

8. GREENING, J. R.: The Photographic Action of X-Rays. Proc. Phys. Soc. B. **64:** 977–992, November 1951.

9. MATHEWSON, D. S.: Effect of Angle of Incidence of Beta Particles on Certain Photographic Film Measurements. Brit. J. Radiol. **29:** 63–64, January 1956.

10. GREENE, D., AND TRANTER, F. W.: Dosage Data for 4,000,000 Volt X Rays. Brit. J. Radiol. **29:** 193–196, April 1956.

11. NEWBERY, G. R., AND BEWLEY, D. K.: The Performance of the Medical Research Council 8 MeV Linear Accelerator. Brit. J. Radiol. **28:** 241–251, May 1955.

12. DAY, M. J.: In Hospital Physicists Association Diagrams and Data Scheme, 1955.

13. JONES, D. E. A.: A Note on Back-Scatter and Depth Doses for Elongated Rectangular X-ray Fields. Brit. J. Radiol. **22:** 342–345, June 1949.

14. WILSON, C. W., AND PERRY, B. J.: Physical Observations Relating to the 2 MeV Van de Graaff Electrostatic Generator at Westminster Hospital. Brit. J. Radiol. **25:** 210–219, April 1952.

15. JONES, D. E. A., GREGORY, C., AND BIRCHALL, I.: Dosage Distribution in Rotational Cobalt 60 Therapy. Brit. J. Radiol. **29:** 196–201, April 1956.

16. SHAPIRO, G., ERNST, W. S., AND OVADIA, J.: Radiation Dose Distribution in Water for 22.5 MeV Peak Roentgen Rays. Radiology **66:** 429–437, March 1956.

17. HOWARTH, J. L.: Calculation of Relative Surface Ionization. Brit. J. Radiol. **24:** 671–675, December 1951.

18. HAYBITTLE, J. L.: Physical Requirements of Beam Defining Systems for Medium Distance Teletherapy Units. Acta radiol. **44:** 505–520, December 1955.

19. FARMER, F. T.: A Sub-Standard X-Ray Dose-Meter. Brit. J. Radiol. **28:** 304–306, June 1955.

20. BOAG, J. W.: The Saturation Curve for Ionization Measurements in Pulsed Radiation Beams. Brit. J. Radiol. **25:** 649–650, December 1952.

21. MILLER, N., AND WILKINSON, J.: II Actinometry and Radiolysis of Pure Liquids. Actinometry of Ionizing Radiations. Disc. Faraday Soc. **12:** 50–60, 1952.

22. DONALDSON, D. M., AND MILLER, N.: Études quantitatives des réactions radiochimiques. III. Oxydation du sulfate ferreux par les particules β. J. chim. physique **52:** 578–586, September 1955.

23. ELLIS, F., SHANKS, W., KEMP, L. A. W., AND OLIVER, R.: The Use of Wedge Filters in X-ray Therapy. J. Fac. Radiologists **1:** 231–244, April 1950.

24. MORRISON, R., NEWBERY, G. R., AND DEELEY, T. J.: Preliminary Report on the Clinical Use of the Medical Research Council 8 MeV Linear Accelerator. Brit. J. Radiol. **29:** 177–186, April 1956.

SUMMARIO IN INTERLINGUA

Mesurationes Physic in un Accelerator Linear a 4 MEV

In le accelerator linear que es describite in iste articulo, un unda electromagnetic con un componente axial de campo electric es dirigite al longo de un guida-unda de maniera que electrones injicite in le guida experientia un augmento de lor energia durante que illos avantia con le unda. Illos attinge un energia final de 4 milliones electron-volts post un viage de 1 m quando illos incontra un scopo de auro del typo transmissional. A iste distantia un dosage de plus que 100 r per minuta (in aere) es obtenite.

Essayos de securitate, con le machina in function de maniera a render un dosage de 100 rads per minuta a un profunditate de 1 cm in un phantasma de aqua con le superficie a un distantia de 1 m ab le scopo, con un campo de 20 x 20 cm, demonstrava que le dosage recipite per le personal, con omne positiones del fasce, esseva ben infra le limites permittite.

Le characteristicas del fasce (symmetria, contamination, energia medie) es discutite. Curvas de isodose es presentate pro campos normal e oblique. Le proportion de ionisation superficial esseva determinate experimentalmente. Le resultatos correspondeva satisfactorimente al valores calculate.

In le practica le dose recipite per le patiente es signalate per un indicator al pulpito de controlo que es connectite con un del cameras de ionisation in le capite del tubo de radios X. Es describite un methodo pro le calibration de doses. Detalios de tractamento non es includite, sed le autores opina in terminos general que le augmentate dose penetratori permitte le irradiation de tumores de sito profunde con un plus basse numero de campos que le numero requirite in le therapia a 250 kv.

Le calculation del dose integral monstra que a 4 MEV illo amonta a solmente circa 60 pro cento del dose integral a 250 kv pro un specific dose al tumor a un profunditate de 10 cm.

New Drugs for Irradiation Sickness[1]

BASIL A. STOLL, F.F.R., M.R.C.S., D. M. R., T. & D.

IN CONTINUANCE of an earlier study of radiation sickness and its management (Ellis and Stoll, 1952), a controlled trial of a series of new drugs has been carried out at the Peter MacCallum Clinic, Melbourne, Australia. Results were recorded on a sheet (Fig. 1) similar to that used in the first investigation. The drug under trial was changed weekly to avoid selection of cases. A lactose tablet was used initially as an inert control, but there was no attempt to make all the drugs up in tablets of similar size, shape, and color. The preparations under trial were pyridoxin hydrochloride; chlorpromazine hydrochloride (Largactil, May and Baker); cyclizine hydrochloride (Marzine, Burroughs Wellcome); Pacatal hydrochloride (William R. Warner). The patient was questioned as to alleviation of symptoms one week after the drug was prescribed. If relief was obtained, the drug was continued for that case until the end of treatment. Otherwise, the drug of the second week was prescribed. A total of 212 drug trials were carried out during a period of eighteen months, ending with April 1956.

Pyridoxin hydrochloride was shown in the previous controlled trial to be the most efficacious of the drugs available at that time, and it is of interest that it afforded relief of symptoms in an almost identical percentage of cases in this study. Its use has been widespread for some years, and some authorities have claimed relief in 90 per cent of cases (Shorvon, 1949). In the last five years, however, various new compounds with anti-emetic action have been introduced.

Chlorpromazine hydrochloride, now widely used for many purposes, was reported by Marks (1954) as relieving symptoms in 80 out of 84 cases of radiation sickness, *i.e.*, in 95 per cent.

For each of these drugs the proportion of relief quoted is very much higher than was obtained in this controlled trial, and a cautious attitude must be adopted when details as to individual symptoms are not supplied. Thus, Loftstrom and Nurnberger (1946), in a report on benadryl, claimed relief of vomiting in 8 out of 10 cases (80 per cent), nausea in 13 out of 19 (68 per cent), anorexia in 8 of 18 (44 per cent), and listlessness in 4 of 13 (31 per cent) cases. These authors reported, with every justification, that some relief of symptoms had been obtained in 18 out of 19 patients, that is, in 95 per cent of their series.

Cyclizine hydrochloride is a new antihistamine compound which has been used recently in the treatment of nausea and vertigo of all types. It has been tried for radiation sickness in the United States, and relief of symptoms has been claimed in 75 to 80 per cent of cases (personal communication). The only side-effect reported is occasional slight drowsiness; no serious toxic symptoms have so far been observed.

Pacatal hydrochloride, like chlorpromazine, is a phenothiazine derivative (chemically, N-methyl piperidyl-3-methyl phenothiazine). It was first introduced for clinical trial in 1954 to cover the fields for which chlorpromazine was promoted, that is, in the treatment of psychoses, as an anti-emetic for vomiting from whatever cause, for sedation in mental stress, and for potentiation of hypnotics and analgesics. It has the advantage over chlorpromazine that its use is accompanied by less tendency to hypotension and less danger of acute mental changes. Another very important advantage is that, to date, there have been no reports of agranulocytosis or jaundice following its administration. It also has a low toxicity and is rapidly eliminated, and

[1] From the Peter MacCallum Clinic, Melbourne, Australia. Accepted for publication in August 1956.

RADIATION REACTIONS

INITIAL DRUG DOSE AND ROUTE ..... For Week Beginning .....

NAME ..... No. ..... Age ..... DISEASE .....

Region Treated ..... Size of fields .....

Date of starting treatment .....

Date						
Control Symptoms						
Nausea						
Vomiting						
Anorexia						
Listlessness						
Toxic Effects						
E.g., Palpitations, dizziness, polyuria, pyrexia, dryness of mouth, skin rashes						

First drug failed after 1 week trial

NEW DRUG .....

Date						
Control Symptoms						
Nausea						
Vomiting						
Anorexia						
Listlessness						
Toxic Effects						
E.g., Palpitations, dizziness, polyuria, pyrexia, dryness of mouth, skin rashes						

Second drug failed after 1 week trial

NEW DRUG .....

Date						
Control Symptoms						
Nausea						
Vomiting						
Anorexia						
Listlessness						
Toxic Effects						
E.g., Palpitations, dizziness, polyuria, pyrexia, dryness of mouth, skin rashes						

Fig. 1. Chart for recording results of tests

is therefore better for use in ambulant patients.

Pharmacologically Pacatal has a depressant effect on the brain, as shown by its antipyretic and anticonvulsant action, and its potentiation of the effects of hypnotics, anesthetics, and analgesics. Like chlorpromazine, it gives protection against centrally induced vomiting. The peripheral effects include a depressant action on the sympathetic nervous system and antagonism to the effect of adrenalin. There is also an anti-histamine effect on the tissues when higher concentrations are used, causing moderate vasoconstriction and preventing local edema.

Before the results obtained with the drugs under trial are discussed, certain deductions arrived at in the previous study should be emphasized:

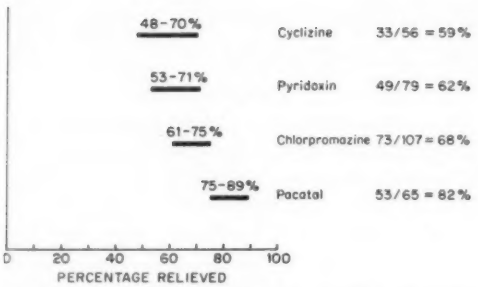

Fig. 2. Effect of individual drugs on nausea and vomiting combined; percentage relieved.

(*a*) Each symptom must be considered separately in its response. Vomiting is the easiest of all radiation sickness symptoms to control; nausea rather less so. Anorexia and lassitude are the most resistant to treatment. The failure to distinguish the response of individual symptoms is, in the writer's opinion, the reason for contradictory reports in the literature, even in controlled series (Silverman *et al.*, 1956).

(*b*) Inert tablets give a surprisingly high proportion of relief of symptoms: in 46 per cent of all cases of vomiting in the previous trial, and in 53 to 75 per cent in the present series.

(*c*) In symptoms arising from irradiation of the abdomen and pelvis, the superiority of an active drug over an inert drug is more evident.

(*d*) In view of the variation of degree of radiation sickness with the site of irradiation, size of field, and daily dose, drugs are best compared on the basis of their efficacy in relation to one specific technic. Postoperative breast irradiation is well suited to this purpose.

The dosages used were as follows:

Pyridoxin hydrochloride	25 mg. q.i.d.
Chlorpromazine hydrochloride	25 mg. q.i.d.
Cyclizine hydrochloride	50 mg. t.d.s.
Pacatal hydrochloride	50 mg. t.d.s.

Injections were given if oral tablets were not effective.

The only side-effect noted in the trial was a tendency to sleepiness with chlorpromazine at the dose stated. Neither Pacatal nor cyclizine produced side-effects of this type.

RESULTS

The data from the recording sheets was transferred to punch cards, and these were hand sorted. From the information collected, the following data were extracted. The term "relief" signifies alleviation of symptoms.

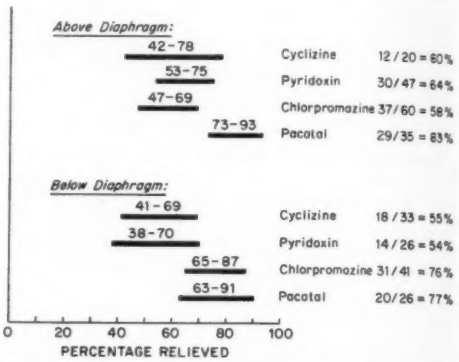

Fig. 3. Effect of individual drugs on nausea and vomiting combined, following irradiation above and below the diaphragm: percentage relieved.

Table I shows the percentage of cases with relief of each symptom by each drug. (The drugs have been arranged, for the purpose of rapid assessment, in their final ascending order of efficacy.) Pacatal might appear to be superior in its relief of every symptom individually, but significant statistical superiority is not shown, because of the size of the samples.

Figure 2 compares statistically the relief of the combined symptoms of nausea and vomiting by each drug. For this purpose, we have expressed the percentage relief at the 10 per cent level of significance, (*i.e.*, with only a 10 per cent possibility of the result being due to chance), using the deviation factor of 1.645 $\sqrt{\frac{C \times (100 - C)}{N}}$. This gives the possible range of the true percentage. When these ranges are plotted on a graph (after Wood and Boag, 1950), it is quite easy to see

TABLE I: RESULTS OF 212 DRUG TRIALS. PERCENTAGE RELIEVED ACCORDING TO INDIVIDUAL SYMPTOMS

	Cyclizine HCl	Pyridoxin HCl	Chlorpromazine HCl	Pacatal HCl
Trials	59	60	71	42
Symptoms				
Nausea	61%	60%	68%	83%
Vomiting	53%	68%	69%	75%
Anorexia	38%	40%	50%	61%
Listlessness	31%	48%	56%	62%

TABLE II: PERCENTAGE RELIEVED BY INDIVIDUAL DRUGS IN A UNIFORM SERIES OF POSTOPERATIVE BREAST CARCINOMA. EFFECT ON NAUSEA AND VOMITING COMBINED

	Cyclizine HCl	Pyridoxin HCl	Chlorpromazine HCl	Pacatal HCl
Trials	9	21	24	18
Percentage relieved	55%	57%	46%	77%

whether one drug is significantly superior, statistically, to another. Thus, in the case of Pacatal, 82 per cent of a series of 65 cases were relieved. The possible limits of this figure, for 90 per cent accuracy, are 75–89 per cent. A line plotted on the graph represents this range and, since it does not overlap the linear range of the other drugs, Pacatal, with a 90 per cent degree of certainty, is superior. Figure 2 shows, therefore, that Pacatal, at the 10 per cent level of significance, is statistically superior to the other three drugs used in its ability to relieve the symptoms of nausea and vomiting.

Figure 3 compares graphically, by the same method as previously, the efficacy of each drug on the combined symptoms of nausea and vomiting, depending upon whether the irradiation given was below the diaphragm (abdomen, lumbar region, or pelvis) or elsewhere (thorax, head and neck, or extremities). It is seen that there is no definite superiority, at the 10 per cent level of significance, of any drug, due to the contents of the sample being split. However, there is a *suggestion* that both Pacatal and chlorpromazine are more efficacious than the other drugs when the irradiation is given below the diaphragm—the area which we concluded previously should distinguish a less active from a more active drug. (There is a strong psychological element in radiation sickness, and it may be that this is proportionately least significant when abdominal irradiation is given.)

Table II shows the effect of individual drugs on the combined symptoms of nausea and vomiting in a homogeneous material, namely, irradiation of the chest wall for breast carcinoma. Here again the size of the sample precludes statistical significance at the 10 per cent level but, as in Table I, Pacatal might be more efficacious than the other drugs at a higher level of significance.

It is unfortunate that the size of the samples precluded any conclusions as to each drug's capacity to relieve the characteristic listlessness and anorexia of the radiation sickness syndrome. Whereas nausea and vomiting in the syndrome are mediated by the center in the cerebral cortex, the other symptoms are presumably not so mediated and would therefore not always respond to the drug with the best anti-emetic properties.

MODE OF ACTION OF DRUGS USED IN IRRADIATION SICKNESS

The symptoms of nausea and vomiting, fatigue, and anorexia, following therapeutic x-ray exposure, are identical with those seen within a few hours following exposure to atomic radiation. Measures of protection against therapeutic x-ray exposure are therefore equally applicable to exposure to irradiation in the time of war.

The cause of radiation sickness is not clear, and it is possible that a different mechanism is involved when different regions are irradiated, as for example the upper abdomen as compared with the chest or extremities. In this respect it was established by Edelman (1951) that, in rats, shielding the adrenal glands will decrease the mortality from irradiation and, conversely, that adrenalectomized animals tolerate irradiation poorly. This would suggest that Doca, cortisone, or ACTH therapy might protect against irradiation sickness, and this has been confirmed clinically by Ellinger (1948), Taber (1951), and Houghton and Walter (1953). Other authors, *e.g.*, Patt *et al.* (1950), have shown a protective effect of cysteine against experimental irradiation.

The symptoms are presumably a result of cell destruction, and chemicals which are known to alleviate the symptoms, such as cysteine and pyridoxin, have an ability to decrease the oxygen content in the tissues. On the other hand, drugs with an anti-histamine action may have beneficial effects in protecting against cerebrally induced nausea and vomiting, but would not be expected to lessen the lassitude and fatigue. A recent paper of Chinn and Wang (1954) deduces that the emesis resulting from irradiation is mediated by the chemoreceptor trigger area adjacent to the vomiting center. Drugs with a selective action on this center will be efficacious in relieving these specific symptoms.

SUMMARY

A controlled trial of new drugs with anti-emetic properties was carried out to determine their efficacy in relieving the symptoms of radiation sickness. The drugs under trial were chlorpromazine hydrochloride, cyclizine hydrochloride, and Pacatal hydrochloride. Their effect was compared with that of pyridoxin hydrochloride, which has been accepted, up to the present, as the most efficacious for this purpose.

Pacatal hydrochloride was shown to be statistically superior to pyridoxin and to all the other drugs tested in the relief of nausea and vomiting. Where these symptoms are due to irradiation of the abdomen, chlorpromazine may possibly be equally efficacious, but its administration has been found to lead to a feeling of sleepiness in some patients, which is a disadvantage in ambulatory cases.

A plea is made for controlled drug trials in the treatment of radiation sickness. Even in such series, the results may be vitiated if the symptoms—nausea, vomiting, anorexia and lassitude—are not considered individually, especially when antiemetic drugs are being evaluated.

ACKNOWLEDGMENTS: I wish to express my thanks to Dr. W. P. Holman, the Medical Director of the Clinic, and to Drs. E. Goodman, N. Johnson, S. J. Rumbold, and J. Starr, whose careful recording of symptoms made this analysis possible; also to Sister A. Gerson, for her supervision of the trial. For free supplies of their drugs, I thank the Melbourne and Sydney representative of Burroughs Wellcome Ltd. (Marzine), May and Baker Ltd. (Largactil), and William R. Warner Ltd. (Pacatal).

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REFERENCES

1. CHINN, H. I., AND WANG, S. C.: Locus of Emetic Action Following Irradiation. Proc. Soc. Exper. Biol. & Med. **85:** 472–474, March 1954.

2. EDELMANN, A.: Survival of Adrenalectomized Rats With and Without Replacement Therapy Following X-Irradiation. Am. J. Physiol. **167:** 345–348, November 1951.

3. ELLINGER, F.: The Use of Adrenal Cortical Hormone in Radiation Sickness. Radiology **51:** 394–399, September 1948.

4. ELLIS, F., AND STOLL, B. A.: Radiation Sickness: A Clinical Investigation. J. Fac. Radiologists **3:** 207–222, January 1952.

5. HOUGHTON, L. E., AND WALTER, J. B.: Treatment of Advanced Malignant Disease with Radiotherapy and ACTH. Letter to Editor. Lancet **1:** 798–799, April 18, 1953.

6. LOFSTROM, J. E., AND NURNBERGER, C. E.: Irradiation Sickness: Histamine Effect Treated with Benadryl. A Preliminary Report. Am. J. Roentgenol. **56:** 211–219, August 1946.

7. MARKS, J. H.: Use of Chlorpromazine in Radiation Sickness and Nausea from Other Causes. New England J. Med. **250:** 999–1001, June 10, 1954.

8. PATT, H. M., SMITH, D. E., TYREE, E. B., AND STRAUBE, R. L.: Further Studies on Modification of Sensitivity to X-Rays by Cysteine. Proc. Soc. Exper. Biol. & Med. **73:** 18–21, January 1950.

9. SHORVON, L. M.: A Further Survey of Radiation Sickness with Particular Reference to its Treatment by Pyridoxine. Brit. J. Radiol. **22:** 49–55, January 1949.

10. SILVERMAN, A., KLIGERMAN, M. M., FERTIG, J. W., AND ELLIS, K.: A Study of the Effectiveness of Pyridoxine and Dramamine on Clinical Radiation Sickness. Radiology **66:** 403–407, March 1956.

11. TABER, K. W.: Treatment of Radiation Sickness with ACTH. A Preliminary Report of Fourteen Cases. Radiology **57:** 702–709, November 1951.

12. WOOD, C. A. P., AND BOAG, J. W.: Researches on the Radiotherapy of Oral Cancer. Medical Research Council Special Report Series, No. 267, 1950.

SUMMARIO IN INTERLINGUA

Nove Drogas Contra Morbo de Irradiation

Un essayo controlate del nove drogas con proprietates anti-emetic esseva executate pro determinar lor efficacia in alleviar le symptomas de morbo de irradiation. Le drogas essayate esseva hydrochloruro de chlorpromazina, hydrochloruro de cyclizina, e hydrochloruro Pacatal. Lor effectos esseva comparate con le effectos de hydrochloruro de pyridoxina, le qual ha essite acceptate como le plus efficace pro le fines in question.

Esseva monstrate que hydrochloruro Pacatal es statisticamente superior a pyridoxina e a omne le altere drogas essayate in su alleviation de nausea e vomito. Quando iste symptomas es effectuate per irritation del abdomine, chlorpromazina ha possibilemente le mesme grado de efficacia, sed in certe casos su administration resulta in un sensation de somnolentia, e isto es un disavantage in patientes ambulatori.

Es signalate le importantia de essayos controlate con drogas usabile in le tractamento de morbo de irradiation. Mesmo in tal series, le resultatos pote esser vitiate si le symptomas—nausea, vomito, anorexia, e lassitude—non es considerate individualmente, specialmente quando il se tracta de evalutar drogas anti-emetic.

Comparative Mortality Following Single Whole-Body Exposures of Mice to Fission Neutrons and Co^{60} Gamma Rays[1]

HOWARD H. VOGEL, Jr., Ph.D., JOHN W. CLARK, M.D., and DONN L. JORDAN, B.S.

DURING THE PAST several years experiments have been planned and undertaken to test the radiobiological additivity of fast neutrons and Co^{60} gamma rays in their acute lethal action on mice (1). Since high-energy gamma rays and fission neutrons are often encountered together, the question of whether they are additive in producing certain biological effects has practical as well as theoretical significance. As a basis for these studies, complete dose-survival curves for the mouse were constructed following exposure to each of the two radiations alone. The object of this paper is to present these survival data for the thirty-day acute period following such exposures.

MATERIAL AND METHODS

Animals: The mice used in these experiments were CF #1 females, shipped to our Laboratories at five to six weeks of age.[2] Upon arrival each week, they were divided into groups of eight, by means of a table of random numbers. Each group was housed in a plastic cage (2) and placed in isolation for two to four weeks before being used in any experiment. The animals were maintained on a diet of Rockland pellets and water *ad libitum*. After the isolation period, the cages were randomly divided into experimental (to be irradiated) and control groups. The animals varied from 20 to 28 gm. in body weight at the time of irradiation.

Methods of Irradiation: All exposures were carried out in a gamma-neutron radiation chamber (3). Fast neutrons were obtained by Zirkle's method (4), in which the thermal column of a reactor is used in conjunction with a plate of uranium to convert slow neutrons to fission neutrons. The experiments were carried out at the CP-3 heavy-water reactor at the Argonne National Laboratory. The slow neutron flux from this reactor was approximately 6×10^7 n/cm.^{2}/sec. at the uranium converter plate of the radiation chamber. The fission neutrons reaching the mice were appropriately filtered against contamination either with pile and fission gamma rays or with thermal neutrons. The slow neutron component reaching the mice was less than 0.5 per cent of the fast neutron component and was therefore of negligible importance in these exposures (5). Contamination from gamma radiation was estimated, by means of carbon chambers and film, to be approximately 7 per cent of the total dose (6).

The spectrum of fast neutrons used in these animal exposures was essentially the fission spectrum (7), slightly modified by transmission through 9 cm. of lead. Studies were made of ionization tracks produced in films irradiated at the animal positions. The spectrum, measured by this technic, extended from the lower limits obtainable with the method (0.5 MEV) to approximately 8 MEV, with a peak between 0.5 and 0.6 MEV and a mean energy of 1.70 MEV.[3] This mean figure would, of course, be decreased if neutrons below 0.5 MEV could have been evaluated. The use of boron and lithium in other film studies confirmed the fact that the slow neutrons reaching the mice were less than 1 per cent of the fast neutron dose.

Pure gamma radiation (1.3316 and 1.1715 MEV) was obtained from eighteen sources of Co^{60} (8) located at the end of the chamber opposite the uranium (3).

[1] From the Division of Biological and Medical Research, Argonne National Laboratory, Lemont, Ill. Work performed under the auspices of the United States Atomic Energy Commission. Accepted for publication in July 1956.

[2] By air express from Carworth Farms, New City, N. Y.

[3] The dosimetry was carried out by Philip F. Gustafson of this Laboratory.

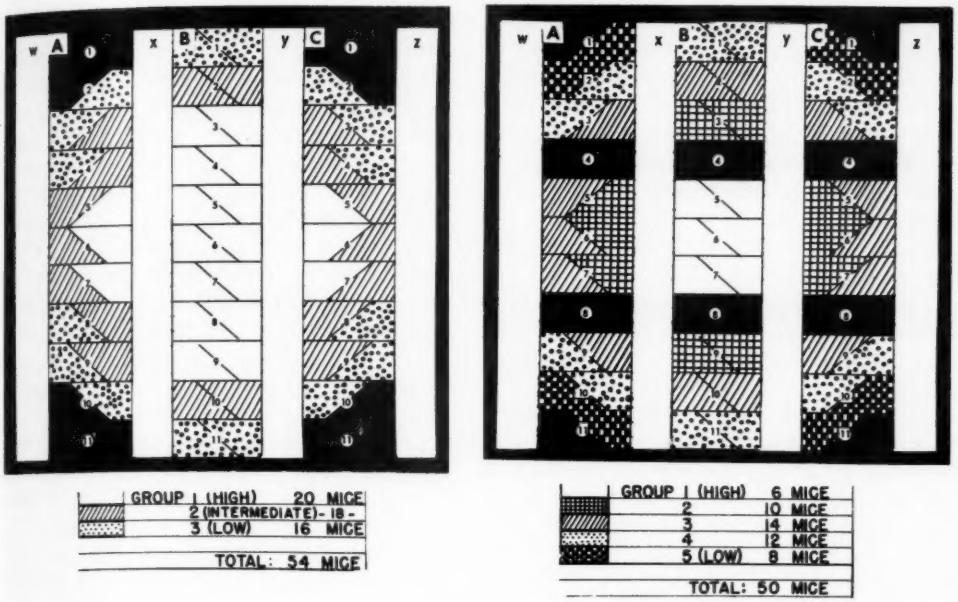
w A x B y C z
GROUP 1 (HIGH) 20 MICE
2 (INTERMEDIATE)- 18 -
3 (LOW) 16 MICE
TOTAL: 54 MICE
GROUP 1 (HIGH) 6 MICE
2 10 MICE
3 14 MICE
4 12 MICE
5 (LOW) 8 MICE
TOTAL: 50 MICE

Fig. 1. Isodose groups used in exposing mice to Co^{60} gamma rays (left) and to fission neutrons (right). W, X, Y, and Z = dosimetry columns.

Animal Exposure Cage and Isodose Groups: Mice were placed in a plastic chamber, 40 × 40 × 5 cm. (3), and were irradiated in a single vertical plane. Since the radiation field was not uniform, it was necessary to determine intensity at each animal position. With the use of a Victoreen rate-meter, isodose groups were established for both gamma and neutron radiations. As indicated in Figure 1, each of the three columns (A, B, and C) in which the mice are irradiated consists of eleven rectangular spaces, subdivided by a diagonal of Lucite. Thus, there are sixty-six exposure cells in the three columns, each of which can hold one animal. Columns W, X, Y, and Z are dosimetry columns by means of which the entire field can be rapidly mapped, with a remotely controlled Victoreen rate-meter probe operating from above the radiation chamber.

For each gamma irradiation, 54 exposed mice were divided into the three isodose groups illustrated in Figure 1 Similarly, five isodose groups were necessary among the 50 neutron-exposed mice. In each case, the intensity of the dose was highest near the center of the exposure cage and decreased toward its periphery, the isodose groups being roughly in the form of concentric ellipsoids. The maximum dose rate variation within each isodose group was less than 2 per cent.

The solid black areas represent positions where no animals were exposed. These spaces were filled with plastic phantoms of approximately the same weight as a mouse.

Each column was covered on both sides by sliding screens of "2S" (high-purity) aluminum. There was sufficient space within each exposure cell for a mouse to turn around.

Dosimetry: Each radiation was monitored by a Victoreen condenser r-chamber (25 r or 100 r) introduced into Column X from the bottom of the exposure cage. The radiosensitive volume was in the same standard position (X_6 in Fig. 1) during exposures. With the aid of Dr. H. H. Rossi of Columbia University, a Victoreen chamber was calibrated with a tissue-equivalent chamber of 10.1 per cent hydrogen compo-

sition. Thus, doses in the fast neutron field could be expressed in terms of roentgen equivalents physical (rep), according to Rossi (6). Under these experimental conditions, 1 "n" unit on a standard 25-r Victoreen chamber was found to be equivalent to 1.89 rep of fast neutrons (6). This calibration was later corroborated by measurements with a Hurst-Ritchie proportional counter (9).

For gamma-ray dosimetry a 25-r Victoreen chamber, with a 4-mm. plastic cap, was calibrated by the National Bureau of Standards for Co^{60} radiation.

Experimental Plan: All exposures in this series of experiments were of ninety minutes duration. Dose rates were 2 to 3 rep per minute for fission neutrons and 8 to 12 r per minute for gamma rays. The total dose to the animals was varied in the neutron irradiations by changing the power level of the reactor, and in the gamma irradiations by altering the source-animal distance.

Over a period of four months, six or seven replicate neutron exposures were carried out at each of three power levels (between 150 and 187 kw). Doses were reproduced accurately for each replicate by increasing or decreasing slightly the power level of the reactor.

Since each of the three power levels included five isodose groups, fifteen different neutron doses were obtained. Several of these, however, could be combined, since the weighted mean doses were similar. By appropriate combinations, eight different doses of fast neutrons were obtained, which were then used to construct a dose-mortality curve. Within each of these combined groups, the weighted mean dose (± 2 per cent) did not differ by more than 3 to 4 rep.

A similar procedure was used for the gamma-ray exposures. Five different distances were selected between the eighteen sources and the center of the animal-exposure position. Four or five replicates were run at each of these settings in order to increase the number of irradiated mice. As in the neutron exposures, the weighted mean doses received by some groups of the gamma-irradiated mice were sufficiently close to allow combination. Within these groups, the weighted mean doses did not differ by more than ± 1 per cent. By such combinations, ten different gamma dose levels were obtained.

Environmental Conditions: The mice were kept at a temperature of $74° \pm 4°$ F. and a relative humidity of approximately 50 per cent in the animal rooms and laboratories. These conditions were also maintained during transportation to and from the reactor, as well as during irradiation.

Control Animals: One group of mice was transported to the reactor with the animals that were to be irradiated. These mobile controls were submitted to the same conditions as the experimental animals with the exception of irradiation. They were loaded into one of the exposure cages, which was then placed inside a control chamber mounted near the radiation chamber. The air supplied to both the experimental and the control mice was temperature- and humidity-controlled by the same climatizer unit during the ninety-minute period of the experiment. Both groups were then transported back to the animal quarters, where they were maintained for the duration of their lives. A second, smaller group of specific controls, randomly selected from every shipment of mice, was also maintained for longevity studies. This group, which never left the animal building, was set up to determine the biological effects of transportation, handling, and caging, by comparison with the mobile controls.[4]

Approximately 2,100 mice were irradiated with either fast neutrons or gamma rays; 1,260 mice served as mobile controls and 220 were selected as stationary controls. An additional 312 mice were irradiated at a later date to confirm dose-mor-

[4] The late biological effects of the radiations utilized will be described in future publications. It can be stated now, however, that no significant differences were observed between the duration of life of these two classes of mobile and stationary controls.

TABLE I: MORTALITY OF CF #1 FEMALE MICE AFTER SINGLE NINETY-MINUTE EXPOSURE TO FISSION NEUTRONS AND Co^{60} GAMMA RAYS

Dose	Number of Mice Exposed	Deaths during 30-Day Post-Irradiation Period	30-Day Mortality (per cent)	Mean Survival Time of 30-Day Decedents (days)
Fission neutrons (rep)				
173	120	10	8.3	15.20
187	140	23	16.4	10.21
195	131	43	32.8	9.53
207	229	102	44.5	9.27
215*	28	15	53.6	10.40
225	190	135	71.1	8.15
233*	20	15	75.0	9.40
243	60	56	93.3	7.52
249	42	42	100.0	6.67
269	36	36	100.0	5.92
	996	477		
CO^{60} gamma rays (r)				
752	136	9	6.6	15.44
788	80	16	20.0	15.31
838	136	30	22.1	15.23
874	144	56	38.9	14.48
910	152	71	46.7	15.38
914*	124	37	29.8	16.83
956*	140	79	56.4	14.71
975	100	60	60.0	14.28
998	90	72	80.0	13.31
1031	164	128	78.0	14.31
1056	72	63	87.5	13.46
1092	80	75	93.8	13.03
	1418	696		

* These exposures were carried out six to eight months after the other irradiations in order to check the dose-mortality curves.

tality data of the earlier work (Table I).

Mortality Tabulation: Death checks were made twice daily in the animal colony. The day of exposure was termed day zero, and all deaths thereafter were recorded on a noon-to-noon basis. Since these studies were primarily for dose-survival data, no mice were sacrificed, nor were histologic studies attempted in this series. However, the bodies of the thirty-day decedents have been preserved for possible future examination.

RESULTS

The total doses of fast neutrons and Co^{60} gamma rays used in these exposures are listed in Table I. The number of mice irradiated at each dose level and the number and percentage of the thirty-day decedents following each radiation are also included in these data.

By means of a probit analysis, using the mortality data for each radiation, it was determined that a dose of 929 ± 5 r of

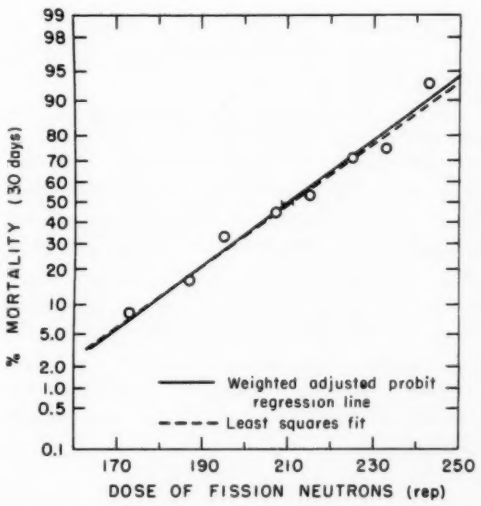

Fig. 2. Probit regression line of thirty-day mortality (per cent) on rep dose of fission neutrons. Slope of line = 0.0091 ± 0.0005. Test for goodness of fit: The residual sum of squares is 0.89 with 8 degrees of freedom. The probability of a greater value of Chi-square by chance alone is $p = 0.52$. Thus the regression line accounts for nearly all the variance and the fit is satisfactory.

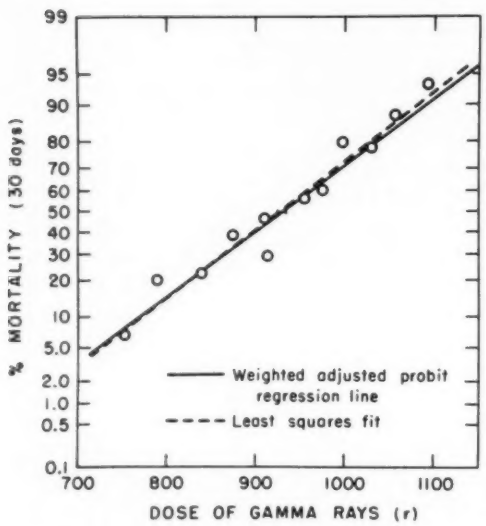

Fig. 3. Probit regression line of thirty-day mortality (per cent) on roentgen dose of Co^{60} gamma rays. Slope of line = 0.0081 ± 0.0004. Test for goodness of fit: Residual sum of squares, not accounted for by the regression, equals 12.75, with 10 degrees of freedom. The probability of a greater value of Chi-square by chance alone is $p = 0.24$. Thus the fit is satisfactory and the probit regression line accounts for all the variability of the experimental points, except for a small amount expected due to chance.

Co^{60} gamma rays would kill 50 per cent of the mice in the acute thirty-day period (30-day LD 50).[5]

Similar analyses of the fast-neutron data showed that the 30-day LD 50 for this ionizing radiation was 209.5 ± 1.1 rep. The weighted, adjusted probit regression lines for acute mortality on dose are shown graphically in Figure 2 for fission neutrons and in Figure 3 for Co^{60} gamma rays. These two regression lines have the same slopes. (Student's "t" test: p = .20, 18 degrees of freedom.)

The relative biological effectiveness (RBE) of these two radiations was calculated to be:

$$\frac{928.7 \text{ r}}{209.5 \text{ rep}} = 4.43$$

In other words, an equivalent physical dose of fission neutrons was 4.43 times more effective than Co^{60} gamma rays in producing death within thirty days, under the conditions of this experiment.

The acute mortality data are illustrated graphically in the dose-response curves (Fig. 4) for each radiation. The dose of fission neutrons is expressed in roentgen

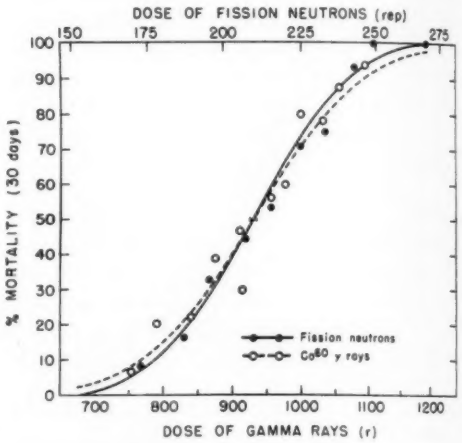

Fig. 4. Mortality following single ninety-minute irradiation of CF #1 female mice with (*a*) fission neutrons, and (*b*) Co^{60} gamma rays.

equivalents physical at the top of the horizontal axis, while the comparable gamma-ray dose, in roentgens, is noted at the bottom of this same axis. The two sigmoid mortality curves have been superimposed at the 50 per cent mortality point.

In order to compare the mortality data following each of the two ionizing radiations, the exposed mice were divided into three dose groups as shown in Table II. The highest group, whether neutron- or gamma-irradiated, showed approximately 80 per cent mortality during the acute period. The intermediate group showed roughly 50 per cent lethality, while only about 20 per cent of the low-dose group died during this period. The mean survival time of the thirty-day decedents in each of these groups is listed in the last column of Table II. These data indicate that with increasing dosage, within the lethal range, the mean survival time of the thirty-day decedents decreased following

[5] Two different methods of analysis were used (10, 11) with almost identical results: 928.7 ± 5.1 r and 928.7 ± 4.7 r.

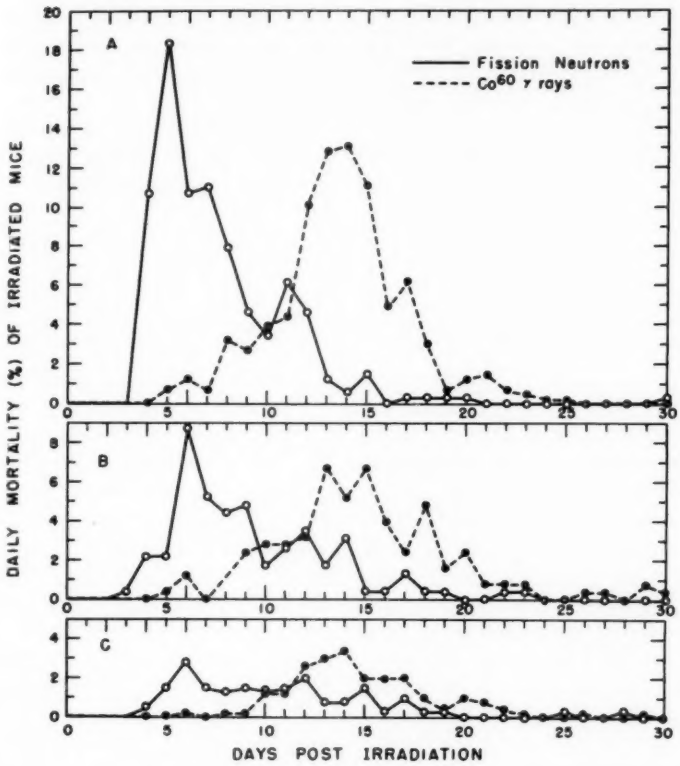

Fig. 5. Comparison of the percentage of irradiated mice dying each day after single exposures to fast neutrons and Co^{60} gamma rays.

both exposures. It is also evident that in mice exposed to fission neutrons death occurred earlier than in mice irradiated with biologically equivalent doses of gamma rays.

In Figure 5 a comparison is made between the mortality patterns following exposure to each of the radiations. This graph summarizes the time of death of more than 1,000 mice dying within the

TABLE II: MEAN SURVIVAL TIME OF THIRTY-DAY DECEDENTS (CF #1 FEMALE MICE) AFTER SINGLE ACUTE EXPOSURE TO TWO IONIZING RADIATIONS

Dose Range	Number of Mice Exposed	Deaths in 30 Days	30-Day Mortality (per cent)	Mean Survival Time of 30-Day Decedents (days)
Fission neutrons (rep)				
224–269	328	269	80	7.4
207	229	102	45	9.3
173–195	391	76	19	10.4
	948	447		
Co^{60} gamma rays (r)				
997–1091	406	338	83	13.6
909–974	252	131	52	14.9
751–874	496	111	22	14.9
	1154	580		

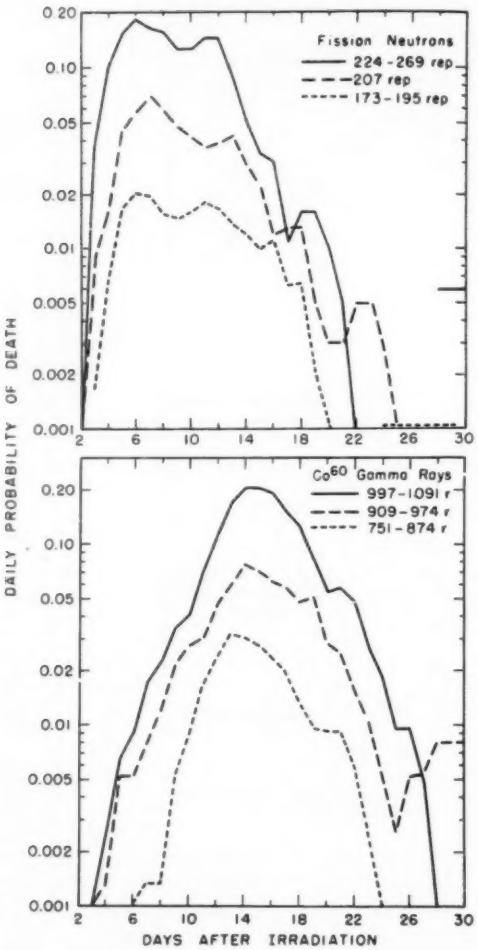

Fig. 6. Comparison of the daily probability of death in CF #1 mice following exposures to fast neutrons (top graph) and Co^{60} gamma rays (bottom graph). The probability of death is calculated by means of three-day running averages.

thirty-day period postirradiation. The same three dose groups, based on comparative mortality (Table II), have been utilized. The vertical axis represents the percentage of the mice dying each day after exposure. This figure emphasizes the different times of death following each of these radiations. After exposure to fission neutrons, in any dose within the lethal range, there was no significant mortality until the fourth day postirradiation. At each of the three dose ranges illustrated, there was a mortality peak on the fifth or sixth day after exposure, a large majority of animals dying between the fourth and ninth days.

Although almost 70 per cent of the thirty-day decedents following neutron irradiation were dead before the tenth day,

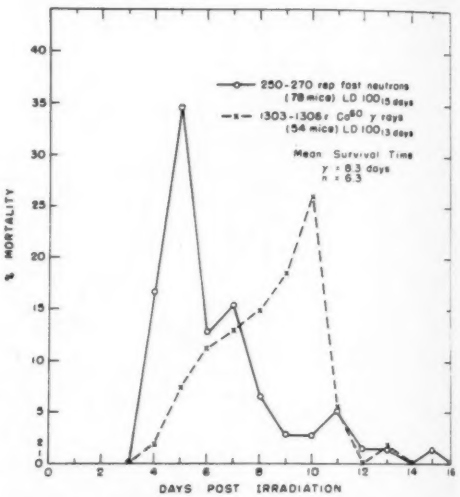
250-270 rep fast neutrons
(78 mice) LD 100 15 days
1303-1306 r Co60 γ rays
(54 mice) LD 100 13 days
Mean Survival Time
γ = 8.3 days
n = 6.3
% MORTALITY
DAYS POST IRRADIATION

Fig. 7. Mortality patterns following single exposures to fission neutrons and Co^{60} gamma rays at comparable doses which killed all the mice within two weeks.

less than 9 per cent of the animals exposed to gamma rays died in this same period. The pattern following irradiation with gamma rays was quite consistent, with a single pronounced peak of mortality around the thirteenth or fourteenth day.

The probablility of death during each twenty-four-hour period following irradiation was calculated by dividing the number of mice dying during that interval by the total number of exposed animals alive at the beginning of the period. This daily probability of death, for each of the three dose groups (Table II), is illustrated graphically in Figure 6. Direct comparison can be made of the three neutron-dose groups with the three gamma-dose groups since they are based on equivalent doses for producing thirty-day mortality. The earlier death following fission neutrons was apparent over the entire lethal range.

From these data it seemed evident that

TABLE III: SURVIVAL TIME OF CF #1 FEMALE MICE IRRADIATED WITH SINGLE HIGH EXPOSURES OF IONIZING RADIATIONS

	Fission Neutrons		Co^{60} Gamma Rays	
Dose (rep)	810*	363–496	(r) 1900	2341–2487
Number of mice exposed	36	30	24	54
Days after irradiation	Number of Animals Dying Each Day			
1	..	..	..	..
2	..	..	..	..
3	..	..	..	..
4	10	10	4	38
5	26	20	13	16
6	..	..	3	..
7	..	..	2	..
8	..	..	2	..
Mean survival time (days)	4.2	4.7	4.8	4.3

* Irradiation at Argonne Research Reactor (CP-5).

the time of death after irradiation was dose-dependent. However, although the two highest doses of fission neutrons killed all the exposed mice, the highest gamma exposure killed only 94 per cent in the thirty-day period. It was suggested by Mole (12) that a dose of gamma rays that would kill all exposed mice in two weeks might give a time-death curve similar to that for the dose of 250 to 270 rep of fission neutrons. In order to test this possibility, 1,305 r of Co^{60} gamma rays were delivered to 54 mice in 1.5 hours. All the mice died within two weeks following exposure. A comparison of the mortality after this irradiation with that following an equivalent dose of fission neutrons is shown in Figure 7, indicating that even at this high gamma dose there were still significant differences in mean survival time after the two ionizing radiations. More than half of the neutron-irradiated mice died on the fourth and fifth days following exposure; less than 10 per cent of the gamma-irradiated mice died in this same period.

It was therefore obvious that even higher doses would be necessary to obtain comparable survival times. In Table III are presented the mean survival times of mice exposed to higher, supralethal doses of each radiation. It should be pointed out that in none of these four exposures did any mouse die until the fourth day post-irradiation, and in three of the four experiments, all animals died on the fourth and fifth days after exposure. The mean survival times of 4.2 to 4.8 days seem similar to those which follow x-ray doses of from 2,000 to 16,000 r, which Quastler has termed "intestinal radiation death" (13). The mean survival time for this type of death seems to vary from approximately 3.6 to 4.2 days in different strains of mice. Although the temporal modes are almost identical, it has not yet been proved that the early neutron deaths are actually intestinal deaths. A series of histologic studies of the small intestines of neutron-irradiated mice is now in progress in an attempt to settle this problem.

DISCUSSION

Comparative studies of the radiobiological effects of these two ionizing radiations are of particular interest because the spatial distribution of energy absorbed from fast neutrons in tissue is markedly different from that from Co^{60} gamma rays (14). Gamma rays dissipate energy in tissue chiefly by means of recoil electrons which lose energy at an average rate (for Co^{60}) of about 0.3 kev per micron of path ($\sim$9 ion pairs per micron). Fission neutrons, on the other hand, dissipate energy largely by recoil protons which lose an average of about 30 kev per micron ($\sim$ 1,000 ion pairs per micron). Thus the linear energy transfer (LET) is one-hundredfold greater for neutrons than for gamma rays and, for equal doses, the total path length is one-hundredth of that for gamma rays. The resultant pattern for

TABLE IV: THE RELATIVE BIOLOGICAL EFFECTIVENESS (RBE) OF SINGLE DOSES OF FAST NEUTRONS AND GAMMA RAYS IN PRODUCING THIRTY-DAY LETHALITY IN MICE

Authors	Mice Used	Radiations	Exposure Time (hours)	Relative Biological Effectiveness (n/x)	(n/γ)
Lawrence and Tennant (18), 1937	Swiss ♂ and ♀	200-kv x-rays; fn ($Be^{+}d$) Cyclotron	Less than 1	$\frac{700\text{ r}}{212\text{ n}^{*}}$ (LD 100/30) = est.	$\frac{980\text{ r}‡}{424\text{ rep}}$ (γ) = ~2.3
Zirkle, Raper, Riley, and Stapleton (4), 1945	CF #1 ♀	γ fn (U fission) ORNL reactor	.75–1.5	(LD 50/30)	$\frac{812\text{ r}†}{91\text{ n}^{*}} = 4.5$
Henshaw, Riley, and Stapleton (19), 1947	CF #1 ♀	γ (Ta^{182}); fn (U fission) ORNL reactor	0.5; Dose rate: γ—30 r/min., n—3 n/min.		$\frac{840\text{ r}}{92\text{ n}^{*}} = 4.6$
Evans (20), 1948	Swiss (Rockland Farms) and CF #1 ♀ and ♂	185-kv x-rays; fn ($Be^{+}d$) Cyclotron	1–1.5	$\frac{630\text{ r}}{78\text{ n}^{*}}$ (LD 50/30) =	$\frac{882\text{ r}(\gamma)‡}{156\text{ rep}} = \sim 5.7$
Hagen and Zirkle (21), 1950	CF #1 ♀	200-kv x-rays; fn ($Be^{+}d$) Cyclotron	1 hr. or less for LD 50	$\frac{540\text{ r}}{54\text{ n}^{*}}$ =	$\frac{756\text{ r}(\gamma)‡}{108\text{ rep}} = \sim 7.0$
Clark, Jordan, and Vogel (22), 1954	CF #1 ♀	γ (Co^{60}); ANL reactor CP-3′ fn (U fission)	1.5; (2–3 rep/min.) ~ 10 r/min.		$\frac{929\text{ r}§}{210\text{ rep}} = 4.4$
Carter, Bond, and Seymour (23), 1954	CF #1 ♀ and ♂	250-kv x-rays; fn ($Be^{+}d$) 60″ Cyclotron U. of Calif. Mean = 9 MEV fn	Dose rate: 80 rep fn/min., 25 r x-ray/min. (0.1–0.2)	♂ $\frac{512\text{ r}}{315\text{ rep}} = \frac{717‡}{315} = 2.3$	
				♀ $\frac{601\text{ r}}{350\text{ rep}} = \frac{841‡}{350} = 2.5$	
Upton, *et al.* (24), 1955	RF	γ (Co^{60}); ORNL 86″ Cyclotron mean effective energy 1 MEV fn	(γ) 55 r/min. Less than 1		$\frac{720\text{ r}}{362\text{ rep}}$ (712–735) (349–376) = 2.0

* In converting "n" or "N" units (as read on Victoreen r-chambers) to rep of fast neutrons, a factor of *2.0* was used in these four studies.
† This value of 812 r was not measured directly, but was determined indirectly from the experimental data.
‡ In the four studies in which x-rays were used, a conversion factor (x/γ) of *1.4* was used so that the final RBE figures could all be compared for n/γ.
§ This value of 930 r for the LD 50/30 was confirmed recently by exposing CF #1 female mice to the gamma radiation from the Co^{60} machine at the Argonne Cancer Hospital at the University of Chicago. The LD 50/30 was approximately 940 r (dose measured in air) or about 880 r (measured in a Lucite phantom) (25). Further exposures of mice of this same strain and sex in the high level gamma-room of Argonne National Laboratory have also substantiated this value for Co^{60} (26).

neutrons is one of short, heavily ionized tracks which are relatively widely separated. In contrast, tracks from gamma rays are more sparsely ionized and much longer (and therefore less widely separated). This difference in relative spatial uniformity of the absorbed energy could be reflected in different basic biological mechanisms. Should such difference in basic mechanisms exist, they might be demonstrable only by a comparison of two radiations of highly different LET. For example, the LET for 250-kv x-rays is only about nine times that for 2-MEV x-rays, in contrast to the hundredfold difference existing for the two radiations used in these experiments.

In comparing the biological effects of fast neutrons and gamma radiation, it is necessary to consider the distribution of absorbed energy throughout the mouse. In the case of fission neutrons only an approximation can be given. If it is assumed that the peak of the energy distribution spectrum of neutrons from thermal fission of U^{235} is about 0.5 MEV, calculations by Tait (15) of the energy deposition curve for a semi-infinite medium indicate that the surface of the mouse toward the uranium converter plate receives about 20 per cent more than the center and that the surface away from the converter receives about 15 per cent less than the center. The fact that the mice are able to turn while in the exposure cage, and that the incident neutrons are not parallel (since they arise from a surface 16 inches square), tends to reduce this variation in dose distribution. An approach to this condition of the semi-infinite slab was attempted by surrounding the mice in the cage with Lucite plastic phantoms, each weighing approximately 25 gm. Tait also concluded that, despite the greater mean free path of neutrons in wet bone as compared to that in soft tissues, the bone marrow did not receive an appreciably higher dose than did the soft tissue.

In the case of the gamma rays from Co^{60}, the variation results mainly from differences in the distance between various parts of the mouse and the eighteen sources. At the highest dose rate, when the mice were closest to these sources, this would result in a total maximum variation throughout the mouse of 6.5 per cent.

Relative Biological Effectiveness (RBE n/γ): Boag (16) recently published a comprehensive review of the relative biological efficiency of different ionizing radiations, including a summary of data on mouse mortality studies. Thomson (17) covered similar material in his review of vertebrate radiobiology, while Zirkle (14) stressed the importance of linear energy transfer in comparative radiation studies.

Table IV summarizes, in chronological order, many of the important investigations on the RBE of fast neutrons and gamma rays in producing acute lethality in mice. It should be pointed out that these data are limited to experiments in which mice were irradiated for one or two hours, or less, thus eliminating several investigations in which the radiation dose was protracted over a twenty-four- or forty-eight-hour period.

The three investigations of fission neutrons from uranium (4, 19, 22) show remarkable agreement, with an RBE of approximately 4.5. Although the other tabulated results (with different cyclotrons as neutron sources) indicate a range of values from approximately 2.0 to 7.0, these differences are not very large when one considers the many variables in the radiation facilities used: The mean energy of neutron beams varied widely at the various cyclotrons (at least from 1 to 9 MEV); the gamma-ray contamination was certainly not identical under the various conditions; widely differing dose rates and methods of dosimetry were employed; different strains of mice were used. It should be emphasized that the RBE concept loses much of its significance unless such factors as the energy of the spectrum and the intensity of the radiations are thoroughly evaluated.

Past investigators have used the twenty-eight- or thirty-day period of "acute radiation mortality" as the biological endpoint for the determination of the relative

TABLE V: THE RELATIVE BIOLOGICAL EFFECTIVENESS OF FISSION NEUTRONS AND Co^{60} GAMMA RAYS FOR PRODUCING EQUAL PROBABILITY OF DEATH (0.50) IN CF #1 FEMALE MICE

Post-irradiation Period (days)	Co^{60} Gamma Rays (r)	Fission Neutrons (rep)	RBE
4 and 5	1690	253	6.3
6, 7, and 8	1270	242	5.2
9, 10, and 11	1180	244	4.8
13 to 30	940	243	3.9

biological effectiveness (RBE) of two radiations. We have already indicated that, if this criterion is accepted as an *equivalent effect* of gamma rays and fission neutrons, then the RBE is 4.43. It is now clear, however, that death within thirty days can occur following several different modes, of which the chief are the "intestinal" and "marrow" modes. It seemed justified, therefore, to try to establish the doses of the two radiations which would produce *equal probabilities of death as a function of time after irradiation*. These data should reflect more accurately the relative biological effectiveness.

The doses of gamma rays and of fast neutrons producing equal probabilities of death for different time intervals after irradiation are given in Table V. It is apparent from these data that the RBE is not a fixed value but varies, for the interval selected, from a high of 6.3 on the fourth and fifth days after exposure to approximately 3.9 from the thirteenth to the thirtieth day postirradiation. This low value after the second post-irradiation week would counterbalance the higher values obtained earlier, averaging out to approximately 4.5 for the entire thirty-day period.

The different temporal patterns of death in mice following exposure to the two ionizing radiations indicate that different mechanisms or patterns of injury may be involved. This hypothesis is further substantiated by two other lines of evidence: (*a*) lack of dose-rate dependence following fission neutrons, in contrast to a highly dependent dose-rate effect after gamma radiation, and (*b*) a departure from additivity when mice are exposed to mixtures of the two radiations (27). A bimodal mortality has been reported to follow x-irradiation of the rat (28), and there is evidence that death occurring early in the post-irradiation period (usually associated with severe diarrhea) seems to be due chiefly to an intestinal syndrome, whereas later deaths, in the acute period, may be largely attributable to damage to the hematopoietic system. It is conceivable that the different peaks of mouse mortality following the two ionizing radiations may be the result, at least in part, of these two syndromes. It is of interest, however, that the relatively short survival time following fast-neutron irradiation in mice was not seen in dogs exposed to fast neutrons at the 70-inch Crocker Laboratory Cyclotron of the University of California (29).

Further experiments are being carried out in an attempt to elucidate possible different mechanisms of mortality in the mouse irradiated with ionizing radiations of different quality.

SUMMARY

1. A group of 2,414 mice were irradiated in the gamma-neutron chamber at Argonne National Laboratory's CP-3′ Reactor; all exposures were for ninety minutes. Thirty-day mortality curves have been constructed for the mouse (CF #1, female) following single whole-body exposure to fission neutrons and Co^{60} gamma rays.

2. A dose of 929 ± 5 r of Co^{60} gamma rays was equivalent to 209.5 ± 1.1 roentgen equivalents physical (rep) of fission neutrons (30-day LD 50). Thus, the relative biological effectiveness (RBE) was 4.43 for this effect under these experimental conditions.

3. A comparison is made of the doses of the two radiations which would produce equal probabilities of death as a function of time after exposure. The concept of RBE is discussed on the basis of these data.

4. After neutron doses (175 to 269 rep) a mortality peak was observed on the fifth or sixth day after exposure; a great majority of the neutron-irradiated mice died between the fourth and the ninth day.

The pattern following gamma irradiation showed a pronounced peak of mortality around the thirteenth or fourteenth day.

5. The daily probability of death was calculated for comparable doses of the two radiations. The earlier occurrence of death following fission neutrons was apparent over the entire range of doses utilized.

6. In addition to the different temporal peaks of mortality, there was additional evidence suggesting that exposure to these two ionizing radiations (different in specific ionization and in linear energy transfer) might produce death in mice by different mechanisms.

7. Comparisons are made with similar work by other investigators. Future experiments to test the additivity of the two radiations, as well as their dependence on dose rate and fractionation, were briefly discussed.

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REFERENCES

1. VOGEL, H. H., JR., ZIRKLE, R. E., AND BRUES, A. M.: Preliminary Report: A Quantitative Test of Radiobiological Additivity of Fast Neutrons and Gamma Rays. Quarterly Report of Biological and Medical Research Division, Argonne National Laboratory, ANL-4451, 1950, pp. 106–108.

2. FLYNN, R. J.: Small Animal Cages. Proc. Animal Care Panel, Fourth Annual Meeting, 1953, pp. 186–188.

3. VOGEL, H. H., JR., BLOMGREN, R. A., AND BOHLIN, N. J. G.: Gamma-Neutron Radiation Chamber for Radiobiological Studies. Nucleonics **11:** 29–31, March 1953.

4. ZIRKLE, R. E., RAPER, J. R., RILEY, E. F., JR., AND STAPLETON, G. E.: Additivity of Fast Neutrons and Gamma Rays in Their Acute Lethal Action on Mice. Atomic Energy Commission Report, AECD-2328, 1945. To be published in the Plutonium Project Record of the National Nuclear Energy Series.

5. WALTON, H., JR.: Thermal Neutron Contribution to a Fast Neutron Exposure. Quarterly Report of Biological and Medical Research Division, Argonne National Laboratory, ANL-5378, 1954, pp. 121–122.

6. ROSSI, H. H.: The *n* Unit and Energy Absorption in Tissue. Radiology **61:** 93–96, July 1953.

7. WATT, B. E.: Energy Spectrum of Neutrons from Thermal Fission of U^{235}. Phys. Rev. **87:** 1037–1041, Sept. 15, 1952.

8. FAN, C.-Y.: Beta-Spectra and Internal Conversion Coefficients for Co^{60}, Nb^{95}, Au^{198}, and Hf^{181}. Phys. Rev. **87:** 252–262, July 15, 1952.

9. MILLS, W. A., Oak Ridge National Laboratory: Personal communication.

10. CORNFIELD, J., AND MANTEL, N.: Some New Aspects of the Application of Maximum Likelihood to the Calculation of the Dosage Response Curve. J. Am. Statistical Assoc. **45:** 181–210, June 1950.

11. TYLER, S. A., AND GURIAN, J.: Determination of the LD_{50} by Use of Probit, Angular and Logit Transformation. Argonne National Laboratory Report, ANL-4486, March 1950.

12. MOLE, R. H., Radiobiological Research Unit, Medical Research Council, Harwell, England: Personal communication.

13. QUASTLER, H.: The Nature of Intestinal Radiation Death. Radiation Res. **4:** 303–320, April 1956.

14. ZIRKLE, R. E.: The Radiobiological Importance of Linear Energy Transfer. In Radiation Biology (A. Hollaender, Editor), New York, McGraw-Hill, 1954. Vol. I, Part I, Chap. 6, pp. 315–350.

15. TAIT, J. H.: The Energy Deposition by Fast Neutrons in Bone Marrow. Atomic Energy Research Establishment, Report AERE-T/R-871, Harwell, 1952.

16. BOAG, J. W.: The Relative Biological Efficiency of Different Ionizing Radiations. National Bureau of Standards Report 2946, 1953.

17. THOMSON, J. F.: Vertebrate Radiobiology (Lethal Actions and Associated Effects). Ann. Rev. Nuclear Sc. **4:** 377–400, 1954.

18. LAWRENCE, J. H., AND TENNANT, R.: Comparative Effects of Neutrons and X-Rays on Whole Body. J. Exper. Med. **66:** 667–688, December 1937.

19. HENSHAW, P. S., RILEY, E. F., AND STAPLETON, G. E.: The Biologic Effects of Pile Radiations. Radiology **49:** 349–360, September 1947.

20. EVANS, T. C.: Effects of Small Daily Doses of Fast Neutrons on Mice. Radiology **50:** 811–834, June 1948.

21. HAGEN, C. W., JR., AND ZIRKLE, R. E.: Comparative Biological Actions of Cyclotron Fast Neutrons and X-Rays. I. Lethal Action on Mice and Rabbits. University of Chicago Metallurgical Laboratory Report, CH-3903, 1950.

22. CLARK, J. W., JORDAN, D. L., AND VOGEL, H. H., JR.: Survival of CF#1 Female Mice after Single Acute Exposures to Co^{60} γ Rays, to Fast Neutrons, and to Mixtures of These Ionizing Radiations. Radiation Res. **1:** 128, February 1954. (Abstract)

23. CARTER, R. E., BOND, V. P., AND SEYMOUR, P. H.: Relative Biological Effectiveness of Fast Neutrons in Mice. Radiation Res. **4:** 413–423, May 1956.

24. UPTON, A. C., CONTE, F. P., HURST, G. S., AND MILLS, W. A.: The Relative Biological Effectiveness of Fast Neutrons, X-Rays, and Gamma-Rays for Acute Lethality in Mice. Radiation Res. **4:** 117–131, February 1956.

25. SIMMONS, E., Argonne Cancer Research Hospital, University of Chicago: Personal communication.

26. VOGEL, H. H., JR., CLARK, J. W., AND JORDAN, D. L.: The Effect of Dose Rate of Co^{60} Gamma Radiation on 30-Day Mouse Mortality and Its Relationship to the "Additivity" of Fast Neutrons and Gamma Rays. Quarterly Report of Biological and Medical Research Division, Argonne National Laboratory, ANL-5486, 1955, pp. 61–64.

27. CLARK, J. W., JORDAN, D. L., AND VOGEL, H. H., JR.: Biological Effects of Fast Neutrons and Gamma Rays. In Proceedings of the International Conference on the Peaceful Uses of Atomic Energy, Geneva, 1955. New York, United Nations, 1956, Vol. 11, 110–114.

28. BOND, V. P., SILVERMAN, M. S., AND CRONKITE, E. P.: Pathogenesis and Pathology of Post-Irradiation Infection. Radiation Res. **1:** 389–400, October 1954.

29. BOND, V. P., CARTER, R. E., ROBERTSON, J. S., SEYMOUR, P. H., AND HECHTER, H. H.: The Effects of Total-Body Fast Neutron Irradiation in Dogs. Radiation Res. **4:** 139–153, February 1956.

SUMMARIO IN INTERLINGUA

Comparation del Mortalitate de Muses Post Unic Expositiones del Corpore Integre a Neutrones de Fission e a Radios Gamma de Co^{60}

In le camera gamma-neutronic del reactor CP-3' al Laboratorio National Argonne, 2.414 muses esseva subjicite a 90 minutas de exposition del corpore total a neutrones de fission o a radios gamma de Co^{44}. Postea curvas de mortalitate esseva construite pro un periodo de 30 dies.

Esseva constatate que un dose de 929 ± 5 r de radios gamma ab Co^{60} equivaleva 209,5 ± 1,1 rep (=roentgeno-equivalente physic) de neutrones de fission (i.e. DL_{50} post 30 dies). In isto, sub le prevalente conditiones experimental, le relative efficacia biologic esseva per consequente 4,43.

Esseva facite un comparation del doses del duo formas de radiation que producerea equal probabilitates de morte exprimite como function del intervallo de tempore depost le exposition. Super iste base il esseva constatate que le relative efficacia biologic variava inter le maximo de 6,3 le quarte e le quinte die post le exposition e un valor vicin a 3,9 que se manteneva ab le dece-tertie usque al trentesime die.

Post doses neutronic (175 a 269 rep), un culmine del mortalitate esseva observate le quinte o le sexte die post le exposition. Le grande majoritate del muses irradiate per neutrones moriva inter le quarte e le none die. Le curva del mortalitate post irradiation gamma monstrava un culmine acute circa le dece-tertie o dece-quarte die.

Le diurne probabilitate de morte esseva calculate pro doses equivalente del duo formas de radiation. Le accelerate mortalitate post neutrones de fission esseva apparente a omne nivellos del scala de doses utilisate.

A parte le differentia temporal del culmines de mortalitate, constatationes additional suggereva que le exposition a iste duo formas de radiation ionisante—differente in ionisation specific e in transferimento de energia linear—resulta possibilemente in le morte del muses per mechanismos que non es identic in le duo casos.

Es facite comparationes con simile recercas per altere investigatores. Planos de experimentation futur, destinate a probar le additivitate del duo radiationes e etiam lor dependentia de dosage e fractionation del doses, es discutite brevemente.

Partial Obstruction of the Inferior Vena Cava by Herniation of the Liver through the Foramen of Morgagni

A Case Report[1]

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HEDBLOM (18), in a review of the literature, reported that 75 per cent of patients with untreated congenital diaphragmatic hernia die before the age of one month. The case to be presented here demonstrates a complication, which we have not found previously described, that may influence morbidity and mortality.

With the exception of herniation through the foramen of Morgagni, congenital diaphragmatic herniations are four to six times commoner on the left than on the right side (12, 33). Reasons for this preponderance may lie in earlier closure of the right leaf of the diaphragm, greater muscular thickness on the right, and the protective barrier afforded by the liver.

The following are the sites of herniation in order of decreasing frequency: (*a*) foramen of Bochdalek, (*b*) dome of the diaphragm, (*c*) esophageal hiatus, (*d*) foramen of Morgagni, (*e*) defect produced by partial absence of a hemidiaphragm, usually posteriorly (15).

The foramen of Morgagni is a triangular defect normally occurring anteromedially in the diaphragm. Its boundaries are the posterior surface of the sternum and the costal and sternal diaphragmatic fibers. This space is filled with fatty areolar tissue (13). Herniation at this site constitutes approximately 2.5 per cent of all congenital diaphragmatic hernias (11, 31).

In his review of the literature, Saltzstein (31) discovered 45 cases of herniation through the foramen of Morgagni, 8 of which were in children under the age of twelve. Four of these were Mongolian idiots, 2 were feebleminded, and 1 had multiple congenital defects. The liver was herniated in 4 patients, 3 children and 1 adult. In 1 of the children, colon was also present in the hernia.

We have found 24 additional cases, proved or apparently certain (2, 7, 10, 13, 15, 17, 20, 21, 24, 25, 29, 30, 33, 35). Six patients were less than twelve years of age. The liver was herniated in 2, both under twelve. No case of liver herniation was reported in the 18 older patients.

Of the 70 cases thus compiled (69 from the literature plus our own) 52 were on the right, 5 on the left, and 13 bilateral. This predilection for the right side is in striking contrast to congenital hernias through other areas of the diaphragm. The reason for it is not known. A hernial sac was usually present.

J. H., a 3-year-old white boy, was admitted to the pediatric service on Nov. 21, 1955, for evaluation of a mediastinal mass. The patient had been born at this hospital, the fourth child of a 32-year-old mother. Pregnancy was uneventful and delivery was effected at term (face presentation). Noticed at birth were facial suffusion and petechiosis and a coloboma of the left iris. The liver was palpated four finger breadths beneath the costal margin and the spleen three. Breath sounds were diminished on the right. A chest film showed segmental atelectasis on the right. The icterus index was 53 and blood urea nitrogen 93 mg. per cent. Liver function tests and serum calcium determinations were normal. Clinical evidence of jaundice and uremia were lacking, but repeat determinations revealed an elevated icterus index and blood urea nitrogen, both of which gradually diminished.

The infant gained weight, hepatosplenomegaly regressed, and the chest cleared. A repeat chest film showed an abnormal configuration of the right heart border. The patient was then discharged to the Out-Patient Department, where retarded mental development was observed. Repeated roentgen studies confirmed the presence of a mass in the right cardiophrenic angle.

At thirty months of age, the child had been readmitted for second-degree burns of the chest.

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Hypaque concentrate used for the angiocardiograms was provided by the Winthrop Laboratories.

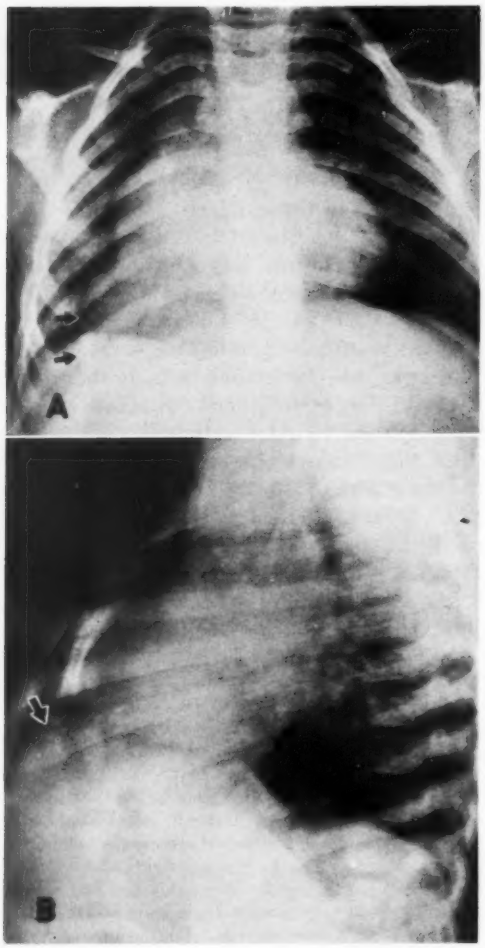

Fig. 1. A. Postero-anterior film of the chest. Arrows point to the mass shadow obliterating the right cardiophrenic angle and extending beneath the diaphragm.

B. Lateral film of chest. Arrow points to the mass in the anterior inferior portion of the chest, overlapping the sternum.

A gastrointestinal series and barium enema study showed the gastrointestinal tract in normal position. A diagnosis of liver herniation was suggested. The patient was discharged.

On admission at the age of three years, because of the mediastinal mass, physical examination revealed evidences of mental deficiency and keloid formation on the anterior chest wall. Blood chemistry findings were within normal limits. Films of the chest (Fig. 1) again showed a mass in the right cardiophrenic angle. In the frontal projection the lateral border of the mass was seen to extend beneath the diaphragm. Diagnostic pneumoperitoneum revealed liver herniation through the anteromedial portion of the diaphragm (Fig. 2).

Angiocardiography, through the right femoral vein, was performed with 10 c.c. of 90 per cent Hypaque concentrate without reaction. A sharp kink in the inferior vena cava, just beneath the diaphragm, was demonstrated. Preferential blood flow occurred through the paravertebral plexus, azygos system, and transhepatic collaterals. The heart appeared to fill chiefly through the superior vena cava (Fig. 3).

At operation, the preoperative diagnosis of liver herniation and kinking of the inferior vena cava was confirmed. Repair was effected by a technic to be reported elsewhere. Postoperative chest films were negative.

A postoperative angiocardiogram, through the left femoral vein, again with 10 c.c. of 90 per cent Hypaque, revealed no caval obstruction, with filling of the heart through the inferior vena cava. The azygos system did not fill (Fig. 4).

Convalescence was uneventful.

DISCUSSION

Herniation of the liver through the foramen of Morgagni has been reported with relative frequency prior to the age of twelve. Its rarity beyond this age raises the question as to what effect this condition may have on longevity. Whether or not caval obstruction may play a role is not known. Certainly, herniation of the liver through other areas of the right diaphragm has been recorded in all age groups.

Perhaps the marked hepatosplenomegaly present at birth in this patient was due to caval obstruction. Regression may have occurred with the development of collateral circulation.

The frequent coexistence of this type of herniation and mental deficiency is perhaps best explained on the basis of multiple congenital defects.

SUMMARY

A case of herniation of the liver through the foramen of Morgagni, with partial obstruction of the inferior vena cava, is presented.

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REFERENCES

1. ARNHEIM, E. E.: Congenital Hernia of the Diaphragm with Special Reference to Right-Sided Hernia of the Liver and Intestines. Surg., Gynec. & Obst. 95: 293–307, September 1952.

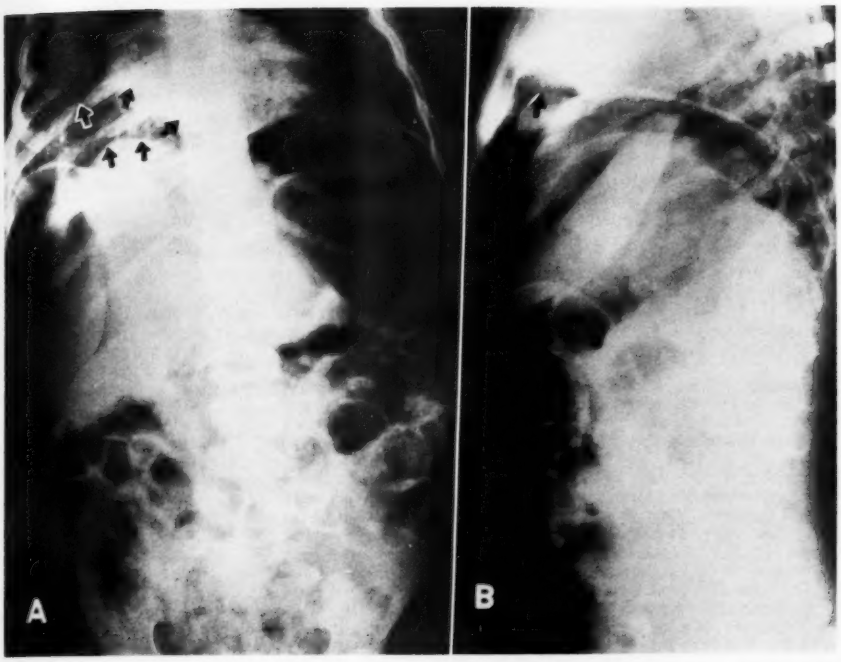

Fig. 2. A. Pneumoperitoneum, anteroposterior position. Arrows point to air outlining the hernial sac and to the herniated liver.
B. Pneumoperitoneum, lateral view. Arrow points to the herniated liver.

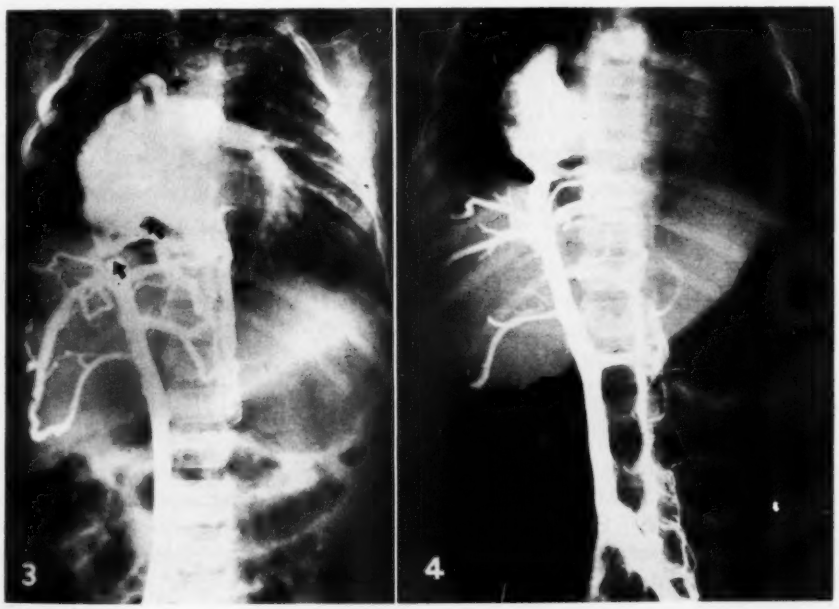

Fig. 3. Preoperative angiocardiogram through right femoral vein, 1-second film. Arrows point to paravertebral and azygos veins, atrioventricular groove, and sharp cut-off in the inferior vena cava. Transhepatic collaterals are prominent.
Fig. 4. Postoperative angiocardiogram through the left femoral vein, 0.5-second film. The azygos system and the sharp caval cut-off are no longer seen. Transhepatic filling is much less marked than preoperatively.

2. BETTS, R. A.: Subcostosternal Diaphragmatic Hernia, with Report of Five Cases. Am. J. Roentgenol. **75:** 269–276, February 1956.

3. BOWERS, V. M., JR., MCELIN, T. W., AND DORSEY, J. M.: Diaphragmatic Hernia in the Newborn. Diagnostic Responsibility of the Obstetrician. J. Obst. & Gynec., N. Y. **6:** 262–172, September 1955.

4. BRADLEY, J. E., AND GREINER, D. J.: Diaphragmatic Hernia. Am. J. Dis. Child. **66:** 143–149, August 1943.

5. BREMER, J. L.: The Diaphragm and Diaphragmatic Hernia. Arch. Path. **36:** 539–549, December 1943.

6. CHILD, C. G., III, HARMON, G. S., DOTTER, C. T., AND STEINBERG, I.: Liver Herniation Simulating Intrathoracic Tumor. J. Thoracic Surg. **21:** 391–393, April 1951.

7. DE NICOLA, R. R., AND VRACIN, D. J.: Diaphragmatic Hernia Through the Foramen of Morgagni. J. Pediat. **36:** 100–104, January 1950.

8. DONOVAN, E. J.: Congenital Diaphragmatic Hernia. Ann. Surg. **122:** 569–581, October 1945.

9. DUTLINGER, R. P., AND FLUKE, S. B.: Non-Traumatic Diaphragmatic Hernia with Complete Evisceration of the Liver. Repair with Tantalum Wire Mesh. Am. J. Surg. **84:** 368–372, September 1952.

10. GANTS, R. T.: Diaphragmatic Hernia: Review of Literature with Report of Illustrative Cases. Ann. Surg. **139:** 166–178, February 1954.

11. GREENWALD, H. M., AND STEINER, M.: Diaphragmatic Hernia in Infancy and in Childhood. Am. J. Dis. Child. **71:** 579–592, June 1946.

12. GROSS, R. E.: Congenital Hernia of the Diaphragm. Am. J. Dis. Child. **71:** 579–592, June 1946.

13. HAJDU, N. H., AND SIDHVA, J. N.: Parasternal Diaphragmatic Hernia through the Foramen of Morgagni. Brit. J. Radiol. **28:** 355–357, July 1955.

14. HARRINGTON, S. W., AND KIRKLIN, B. R.: The Clinical and Roentgenologic Manifestations and Surgical Treatment of Diaphragmatic Hernia, with a Review of 131 Cases. Radiology **30:** 147–156, February 1938.

15. HARRINGTON, S. W.: Diaphragmatic Hernia of Children. Ann. Surg. **115:** 705–715, April 1942.

16. HARRINGTON, S. W.: Surgical Treatment of the More Common Types of Diaphragmatic Hernia: Esophageal Hiatus, Traumatic, Pleuroperitoneal Hiatus, Congenital Absence and Foramen Morgagni. Report of 404 Cases. Ann. Surg. **122:** 546–568, October 1945.

17. HARTZELL, J. B.: Diaphragmatic Hernia in Children. Résumé of 68 Cases Occurring in Children under 10 Years of Age Treated by Operation. Am. J. Surg. **48:** 582–598, June 1950.

18. HEDBLOM, C. A.: Diaphragmatic Hernia. Ann. Int. Med. **8:** 156–176, August 1934.

19. HOLLANDER, A. G., AND DUGAN, D. J.: Herniation of the Liver. J. Thoracic Surg. **29:** 357–367, April 1955.

20. JOHNSON, E. K., AND MANGIARDI, J. L.: Subcostosternal Diaphragmatic Hernia. Am. J. Surg. **84:** 245–248, August 1952.

21. JOHNSON, W. W.: Diaphragmatic Hernia through the Foramen of Morgagni. New York State J. Med. **49:** 1842–1844, Aug. 1, 1949.

22. KNOEPP, L. F.: Unusual Diaphragmatic Hernia with Displaced Liver. J. Thoracic Surg. **21:** 394–397, April 1951.

23. LADD, W. E., AND GROSS, R. E.: Congenital Diaphragmatic Hernia. New England J. Med. **223:** 917–925, Dec. 5, 1940.

24. MARKS, J. H.: Diaphragmatic Hernia and Associated Conditions. Am. J. Roentgenol. **37:** 613–632, May 1937.

25. MORTON, J. J.: Herniation through the Diaphragm. Surg., Gynec. & Obst. **68:** 257–277, February 1939.

26. NEVILLE, W. E., AND CLOWES, G. H., JR.: Congenital Absence of Hemidiaphragm and Use of a Lobe of Liver in Its Surgical Correction. Arch. Surg. **69:** 282–290, September 1954.

27. POPPEL, M. H., ABRAMS, R. M., HANDELSMAN, J., AND SEGAL, A.: Diaphragmatic Herniation of the Pancreas. Radiology **63:** 91–93, July 1954.

28. RAVITCH, M. M., AND HANDELSMAN, J. C.: Defects in the Right Diaphragm of Infants and Children with Herniation of Liver. Arch. Surg. **64:** 794–802, June 1952.

29. RIKER, W. L.: Congenital Diaphragmatic Hernia. Arch. Surg. **69:** 291–306, September 1954.

30. RITVO, M., AND PETERSON, O. S., JR.: Parasternal Diaphragmatic Hernia. Am. J. Roentgenol. **52:** 399–405, October 1944.

31. SALTZSTEIN, H. C., LINKNER, L. M., AND SCHEINBERG, S. R.: Subcostosternal (Morgagni) Diaphragmatic Hernia. Report of Case of Hernia Containing Stomach, Transverse Colon, and Omentum, with Review of Literature. Arch. Surg. **63:** 750–765, December 1951.

32. STOREY, C. F., AND KURTZ, L. D.: Congenital Hernia Through the Dome of the Right Diaphragm in an Adult. Am. J. Surg. **81:** 363–367, March 1951.

33. THOMSON, S. A.: Diaphragmatic Hernia in Infancy and Childhood. S. Clin. North America **34:** 997–1005, August 1954.

34. UNGER, A. S., AND POPPEL, M. H.: Diaphragmatic Hernia. Am. J. Roentgenol. **37:** 472–478, April 1937.

35. WATKINS, D. H., HARPER, F. R., AND CONDON, W. B.: Diaphragmatic Hernias with Visceral Complications. Arch. Surg. **65:** 95–108, July 1952.

SUMMARIO IN INTERLINGUA

Obstruction Partial del Vena Cave Inferior per Herniation del Hepate a Transverso le Foramine de Morgagni: Reporto de Un Caso

Sexanta-nove casos de herniation a transverso le foramine de Morgagni esseva colligite in le litteratura. Es reportate un caso additional. Dece-cinque del patientes, incluse le patiente del autor, habeva etates de minus que dece-duo annos. In 52 del casos, le hernia occurreva al latere dextere. Isto contrasta con hernias congenite a transverso altere areas del diaphragma. In sex del previe reportos e in le caso del autor, il se tractava de herniation del hepate.

Le examine angiocardiographic del patiente hic reportate monstrava un inflexion abrupte del vena cave inferior justo infra le diaphragma. Post le correction chirurgic del hernia, un angiocardiogramma revelava nulle obstruction caval.

Roentgen Manifestations of Psoriatic Arthritis[1]

THOMAS F. MEANEY, M.D.,[2] and ROBERT A. HAYS, M.D.

PSORIATIC ARTHRITIS, as commonly understood, is an arthritis affecting patients with long-standing psoriasis. The joint manifestations predominantly involve the hands and usually are associated with psoriatic changes in the nails.

The term *psoriatic arthritis* has been the source of much controversy since the condition was described by Bourdillon (2) in 1888. The discussion centers about whether psoriatic arthritis is an entity in itself or merely represents the association of psoriasis with rheumatoid arthritis. It is the purpose of this paper to propose a two-group classification of the concurrence of psoriasis and arthritis on the basis of the roentgen findings in 15 patients.

The background for much of the controversy concerning psoriatic arthritis possibly stems from the study by Dawson and Tyson (5) who, in 1,000 cases of rheumatoid arthritis, found the incidence of psoriasis to be 2.6 per cent, as compared with only 0.3 per cent in 1,000 cases of osteoarthritis. The significance of these figures apparently has been misinterpreted by many, and they have been used as partial evidence that when arthritis occurs in patients with psoriasis, it is of the rheumatoid type. Although it is true that most patients with psoriasis present the classic clinical and roentgen changes of rheumatoid arthritis, a few are seen with atypical changes. There is clinical, histopathologic, and roentgen evidence that an arthritis exists in association with psoriasis which is not of the rheumatoid type. While this report is concerned primarily with the roentgen manifestations, a few points of clinical and pathologic interest will be reviewed.

Many observers claim that there is a parallelism between the psoriasis and the arthritis, that is, when there is an exacerbation of the psoriasis, the arthritis flares; with the remission of the psoriasis, the arthritis improves. There is, however, a division of opinion on this point. An analysis shows that those who favor the concept that the arthritis is of the rheumatoid type are also those who emphasize the parallelism (3, 4, 6, 9, 10). This is perfectly consistent, since many intercurrent diseases may cause an exacerbation of rheumatoid arthritis, which tends to subside when the associated condition has been alleviated. The conclusion cannot be ignored that psoriasis acts as a nonspecific stimulus for the flare-up of an existing arthritis, particularly if it is of the rheumatoid type.

The almost constant involvement of the fingernails by the psoriatic process in those patients manifesting arthritis of the hands is well recognized. Cases such as those presented by Nunemaker and Hartman (12), in which only the fingers affected by the arthritic process showed psoriatic lesions of the nails, appear significant. It seems unlikely that it is merely by chance that in these patients the arthritic changes were limited to fingers with psoriatic involvement of the nails. Dawson and Tyson also emphasize that there is a definite anatomic distribution of psoriasis and arthritis, with a tendency of both diseases to affect the same digits. In the absence of involvement of the proximal interphalangeal joints, flexion deformities of the terminal interphalangeal joints, such as those seen in psoriatic arthritis, are extremely uncommon in rheumatoid arthritis. Also, the bilateral and symmetrical distribution of rheumatoid arthritis is lacking.

Histopathologic evidence indicates ab-

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Fig. 1. Typical roentgen findings of rheumatoid arthritis in a patient with psoriasis. Generalized demineralization, narrowed joint spaces, and bony erosion are the salient features.

sence of the usual rheumatoid changes in the terminal interphalangeal joints involved by psoriasis. Bauer, Bennett, and Zeller (1) examined the hand of a patient having psoriasis with associated arthritis and found no bony atrophy such as that which occurs in rheumatoid arthritis. A dense fibrous tissue filled the involved joint spaces without evidence of inflammatory change; the proximal interphalangeal joints were not affected. Sherman (14), more recently, studied biopsy material from 33 involved joints of patients with psoriatic arthritis. She found a fairly constant pattern that, although not pathognomonic of psoriatic arthritis, was not typical of rheumatoid arthritis. In addition, none of her patients exhibited the rheumatoid type of ulnar deviation of the hand, atrophy of the skin, subcutaneous nodules, or cardiac changes. Edema and fibrosis of the synovial and perisynovial tissues were found to be striking features of the early stages. The articular margins were involved, with resulting erosions. Later in the course of the disease, fibrosis predominated, with destruction of joint surfaces and of the cortical bone along the shaft, progressing to complete dissolution of the joint, with only stubs of bone remaining. The joint space at that stage was filled with fibrous tissue. Sherman did not find pannus formation or subchondral invasion in any of her patients.

If the destructive process is arrested at any time, the body will attempt to repair the damage by fibrous or bony union. These histopathologic responses can be correlated with the typical roentgen picture seen in psoriatic arthritis.

The roentgen findings in rheumatoid arthritis of the hand are readily recognized. They usually consist of generalized demineralization of the bones and changes in the proximal interphalangeal joints. As will be seen in the cases of this study, and from many previously reported cases of arthritis with psoriasis (7, 12–15), a peculiar manifestation is the involvement of the terminal interphalangeal joints. In rheumatoid arthritis, changes in the distal joints almost aways occur late in the course of the disease and are associated with pronounced involvement of the proximal interphalangeal joints.

MATERIAL AND FINDINGS

The material for our study consists of roentgenograms of the hands of 15 patients with psoriasis and arthritis, in whom bone and joint abnormalities were demonstrated by roentgenography. The hand was selected for study because it is so frequently the site of arthritic changes and because the roentgen findings are easily compared with those of other forms of arthritis.

The roentgen findings may be grouped into two categories: (*a*) changes typical of rheumatoid arthritis, which we believe should be designated as *psoriasis with rheumatoid arthritis*, and (*b*) changes atypical of rheumatoid arthritis, to be discussed below, for which we reserve the term *psoriatic arthritis*.

(*a*) *Psoriasis with Rheumatoid Arthritis:* In the first category, composed of 11 patients, the usual roentgen manifestations

of rheumatoid arthritis of the hand were apparent. These consisted of generalized demineralization of bone, narrowing of the joint spaces, some erosion about the articular surfaces, and soft-tissue swelling about the involved joints. These changes predominated in the proximal interphalangeal joints. The hand of one of these patients is shown in Figure 1.

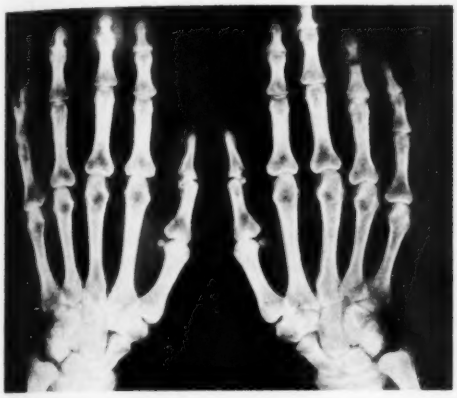

Fig. 2. Psoriatic arthritis. There is no generalized demineralization, despite the advanced changes in the terminal interphalangeal joints of both hands. Two joints show almost complete lysis.

Fig. 3. Photograph of the hands shown in Figure 2, with psoriatic skin lesions and soft-tissue swelling about the terminal interphalangeal joints. Pronounced psoriatic involvement of the fingernails was present but is unfortunately obscured in the photograph by the nail polish.

Fig. 4. Psoriatic arthritis. Articular erosion is present in the terminal interphalangeal joint of the fourth finger and to a lesser extent in the third finger. There is minimal erosion in the proximal interphalangeal joint of the fourth finger.

(*b*) *Psoriatic Arthritis:* In the second category were 4 patients with changes atypical for rheumatoid arthritis. The roentgenograms revealed (a) lack of generalized demineralization of bone; (b) destructive changes in the terminal interphalangeal joints without associated involvement of the proximal joints or, at most, with minimal involvement; and (c) destructive changes in the terminal interphalangeal joints associated with hypertrophic changes about these joints, but differentiated from osteoarthritis by the presence of severe articular destruction.

The destructive articular changes are well illustrated in a patient whose roentgenogram (Fig. 2) shows complete lysis of two terminal interphalangeal joints and gross articular erosion in four other terminal joints; the proximal interphalangeal joints are not involved. A photograph of

this patient's hands is shown in Figure 3.

An earlier stage is shown in the roentgenogram of the hand of a second patient (Fig. 4). Articular destruction is present in the terminal interphalangeal joint of the fourth finger. Although there are minimal joint changes in the proximal interphalangeal joint of this finger, these are not of the usual rheumatoid type.

Examination of the hand in the 2 remaining patients revealed unusual features. The first of these (Fig. 5) exhibited very prominent hypertrophic changes in both the proximal and distal interphalangeal joints. Although there is some articular erosion in the proximal joints, the hypertrophic changes in the terminal interphalangeal joints are associated with extreme destructive lesions. The fourth pa-

Fig. 5. Prominent hypertrophic changes in association with articular destruction. Moderate articular erosion is present in some of the proximal joints but more advanced changes are seen in the distal interphalangeal joints. Note also the flexion deformities of the terminal joints.

Fig. 6. The left hand (A) shows articular destruction in the terminal interphalangeal joints of the second and third fingers and fusion of the terminal joints of the fourth and fifth fingers. All of the terminal joints of the right hand (B) are fused.

tient also presented hypertrophic changes in two of the terminal interphalangeal joints, with articular erosion. The fourth and fifth joints of this hand were fused (Fig. 6A), and all four terminal joints on the left hand were fused (Fig. 6B). It appears that the destructive lesions in the two fingers of the right hand represented the earlier changes, and the fusion of the other fingers was the end-result of a similar destructive process. It also appears significant that the proximal interphalangeal joints of both hands show minimal changes.

SUMMARY

The roentgen findings in 15 patients having psoriasis and arthritis are grouped into two categories. The first group consists of changes typical of rheumatoid arthritis, for which the term *psoriasis with rheumatoid arthritis* is used. The second group consists of findings that are not typical of rheumatoid arthritis, including varying degrees of articular destruction involving the terminal interphalangeal joints which may progress to actual lysis of the joint and eventual fibrous or bony fusion. Depending upon the reaction of the patient to the disease, hypertrophic arthritic changes may be associated with these findings. Generalized demineralization of bone is not a feature of this second group. It is believed that the roentgen changes found in the second group represent a distinct type of arthritis, for which the appropriate term is *psoriatic arthritis*.

REFERENCES

1. BAUER, W., BENNETT, G. A., AND ZELLER, J. W.: The Pathology of Joint Lesions in Patients with Psoriasis and Arthritis. Tr. A. Am. Physicians **56:** 349–352, 1941.
2. BOURDILLON, C.: Psoriasis et arthropathies. Paris, 1888.
3. COMROE, B. J.: Arthritis and Allied Conditions. Philadelphia, Lea and Febiger, 3d ed., 1944, pp. 130–135.
4. DAWSON, M. H.: Note on Occurrence of Psoriasis in Rheumatoid Arthritis. M. Clin. North America **21:** 1807–1808, November 1937.
5. DAWSON, M. H., AND TYSON, T. L.: Psoriasis Arthropathica, with Observations on Certain Features Common to Psoriasis and Rheumatoid Arthritis. Tr. A. Am. Physicians **53:** 303–309, 1938.
6. EPSTEIN, E.: Differential Diagnosis of Keratosis Blennorrhagica and Psoriasis Arthropathica. Arch. Dermat. & Syph. **40:** 547–559, October 1939.
7. FAWCITT, J.: Bone and Joint Changes Associated with Psoriasis. Brit. J. Radiol. **23:** 440–453, July 1950.
8. HENCH, P. S.: Recent Investigations on Rheumatism and Arthritis in the United States. Ann. Rheumat. Dis. **2:** 19–40, April 1940.
9. HENCH, P. S., ET AL.: Present Status of Rheumatism and Arthritis: Review of American and English Literature for 1936. Ann. Int. Med. **11:** 1089–1247, January 1938.
10. JEGHERS, H., AND ROBINSON, L. J.: Arthropathia Psoriatica; Report of Case and Discussion of Pathogenesis, Diagnosis and Treatment. J.A.M.A. **108:** 949–952, March 20, 1937.
11. MADDEN, J. F.: Psoriasis. Clinical and Laboratory Statistical Study. Minnesota Med. **22:** 381–385, June 1939.
12. NUNEMAKER, J. C., AND HARTMAN, S. A.: Psoriatic Arthritis. Ann. Int. Med. **33:** 1016–1023, October 1950.
13. PLENK, H. P.: Psoriatic Arthritis; Report of Case. Am. J. Roentgenol. **64:** 635–639, October 1950.
14. SHERMAN, M. S.: Psoriatic Arthritis. Observations on the Clinical, Roentgenographic, and Pathological Changes. J. Bone & Joint Surg. **34-A:** 831–852, October 1952.
15. STERNE, E. H., JR., AND SCHNEIDER, B.: Psoriatic Arthritis. Ann. Int. Med. **38:** 512–522, March 1953.

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SUMMARIO IN INTERLINGUA

Manifestationes Roentgenologic de Arthritis Psoriatic

Le constatationes roentgenologic in 15 patientes con psoriasis e arthritis es gruppate in duo categorias. Le prime gruppo consiste de alterationes typic de arthritis rheumatoide. Pro illos le termino *psoriasis con arthritis rheumatoide* es usate. Le secunde gruppo consiste de constatationes que non es typic de arthritis rheumatoide. Illos include varie grados de destruction articular termino-interphalangeal que pote progreder usque a un genuin lyse del articulationes con subsequente fusion fibrose e ossee. In dependentia del reaction al morbo manifeste in le patiente, hypertrophic alterationes arthritic pote esser associate con iste constatationes. Generalisate dismineralisation ossee non es un characteristica de iste secunde gruppo. Es opinate que iste alterationes representa un typo distincte de arthritis. Le termino appropriate pro illo es *arthritis psoriatic*.

Soft-Tissue Placentography in Diagnosis of Bicornuate Uterus[1]

ROBERT B. ENGLE, M.D., GEORGE JACOBSON, M.D., and ELEANOR R. FRASER, M.D.[2]

ANOMALIES OF fusion of the uterus are important as a source of complications during pregnancy. Malformations resulting from abnormal fusion of the müllerian ducts range from the rare uterus didelphys (two uteri, two cervices, and two vaginae) to the nearly normal uterus arcuatus, which in the non-pregnant state shows only a fundal concavity but during pregnancy exhibits marked abnormalities of contour. The most common anomaly, arcuate uterus, was found by Falls (2) in 3.8 per cent of deliveries. Some of these anomalies of uterine septation are relatively rare and do not concern us in this paper. Uterus bicornis unicollis, with a double uterus and a single cervix, uterus septus and subseptus, presenting variable degrees of septation arising from the uterine fundus, and uterus arcuatus are sometimes grouped together and termed bicornuate uterus. All of these are of interest here.

The purpose of the present paper is to describe the roentgenographic findings which may lead to suspicion of bicornuate uterus.

Fig. 1. Case I. Pregnancy in bicornuate uterus. The fetal head rests in one upper abdominal quadrant and the lower extremities in the other. The spine is only slightly flexed, producing an appearance as though the fetus rested in a hammock.

OBSTETRICAL SIGNIFICANCE

Anomalous malformations of the uterus predispose to a variety of gynecological as well as obstetrical complications. The extra area of endometrium may result in menorrhagia; the poorer egress of menstrual products may lead to dysmenorrhea. During pregnancy the anomalous shape of the uterus results in faulty implantations with a high incidence of abortion (1), premature separation of the placenta, and placenta praevia (5). Labor may be prolonged or there may even be uterine rupture due to the weak or deficient musculature of the anomalous uterus (5). Premature rupture of the membranes (3) and premature labor are frequent. Dystocia may occur as a result of impaction of the non-pregnant horn of the uterus and may necessitate cesarean section. Prolapse may also complicate delivery. Retained placenta and postpartum hemorrhage are other possibilities (4).

Abnormal presentations include the breech and transverse types. It is easy to understand that the fetus would take up an unusual position in a deformed cavity. Falls (2) has described a transverse oblique presentation in arcuate uterus and considers this position practically pathognomonic in a primiparous patient. Jarcho (4) reproduced a roentgenogram of an abnormal presentation associated with arcuate uterus but made no comment.

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[1] From the Departments of Radiology, School of Medicine, University of Southern California and the Los Angeles County Hospital. Accepted for publication in July 1956.

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CASE REPORTS

CASE I: Mrs. F. F., 24 years old, para i, gravida ii, entered the hospital Feb. 19, 1954. She had passed a cupful of bright red blood per vagina one and one-half hours previously, after which low back pain developed. Her previous pregnancy had terminated, after difficult labor, in delivery of a 5-pound child.

On physical examination, the fundus of the uterus was found to be 25 cm. above the symphysis pubis, and to have a transverse diameter of 27 cm. The perineum was smeared with blood. A soft-tissue placentogram (Fig. 1) showed a central placenta praevia with a fetus in "hammock" position.

The patient continued to bleed, and a sterile vaginal examination disclosed a central placenta praevia. Cesarean section revealed a bicornuate uterus, with generalized hemorrhagic areas in the wall, and 15 per cent abruptio placentae. A viable male infant was delivered.

Fig. 2. Case II. Pregnancy in bicornuate uterus. Although the fetal sacrum rests deeper in the maternal pelvis, the fetal head and lower extremities are widely separated and the spine is relatively unflexed.

CASE II: Mrs. A. W., 27 years old, para 0, gravida i, entered the hospital Dec. 30, 1951, stating that the membranes had ruptured the previous night. There had been no pain or bleeding. The last menstrual period had begun on May 12. The expected date of delivery was Feb. 19. There was a history of pelvic inflammatory disease in 1949.

Physical examination showed the fundus of the uterus 23 cm. above the symphysis pubis. The fetus was in transverse position with the head in the right upper quadrant. On a soft-tissue placentogram (Fig. 2), the fetus was seen to be in "hammock" position.

Fig. 3. Case III. Pregnancy in bicornuate uterus. Except for slight rotation, the attitude of the fetus is almost identical to that seen in Case 2.

A 5-lb. 10-oz. male fetus was delivered by breech extraction. The placenta was noted to be incomplete. Manual examination revealed retained fragments, as well as a bicornuate uterus with a partial septum not including the cervix.

CASE III: Mrs. L. B., 24 years old, para i, gravida iii, was admitted on Sept. 21, 1955, because of bloody show and irregular contractions. Her last menstrual period began Dec. 25, 1954, and the expected date of delivery was Oct. 2, 1955. She gave a history of spontaneous abortion at six weeks in 1951 and of full-term normal delivery of a 5-lb. 13-oz. infant after twelve hours of labor in 1953.

On physical examination, the fundus of the uterus appeared to be "at term"; the fetus was in the right sacrum anterior position, single footling. The cervix was dilated 1 cm. A soft-tissue placentogram (Fig. 3) revealed a breech presentation with the fetus in "hammock" position.

After three hours, with pains occurring every five minutes, the cervix was dilated 2 cm. On vaginal examination marginal placenta praevia was felt, with a breech floating very high above the symphysis.

Cesarean section revealed a typical bicornuate uterus, divided almost to the internal os. The infant was in the right horn, and the placenta in the left horn, attached posteriorly and extending to the margin of the cervix.

Fig. 4. Transverse lie. The fetal spine is flexed and the legs are drawn toward the head in contrast to the attitude in the bicornuate uterus.

DISCUSSION

In the 3 cases reported, the diagnosis of bicornuate uterus was evident from an anteroposterior soft-tissue placentogram, showing a modified breech presentation with the head and body toward one side of the abdomen, the sacrum dependent, and the legs separated from the trunk and extending toward the opposite side of the abdomen. This languid posture resembles that assumed by a person lying in a hammock. The separation of the legs from the rest of the body suggests an absence of the usual compressing effect of the uterus, and it may be that the body rests in one uterine horn and the legs in the other. We believe that a bicornuate uterus, or one of its variants, may be suspected when the fetus takes this position.

In the differential diagnosis a transverse lie in a normal uterus must always be considered. This is readily distinguishable, since in this condition the fetal spine shows a greater degree of flexion and the lower extremities are drawn up toward and frequently are in contact with the head and upper extremities (Fig. 4).

SUMMARY

1. Three cases of bicornuate uterus are described, in which the diagnosis was suggested on the anteroposterior radiograph of the abdomen.

2. In this anomaly, the fetus frequently assumes an attitude as though lying in a hammock.

3. The early diagnosis of bicornuate uterus may be of value in alerting the obstetrician to possible complications of delivery.

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REFERENCES

1. BRADLEY, J. J., COLOZZI, A. E., AND LINTHWAITE, R. F.: Uterus Bicornis Unicollis, Vagina Simplex. Am. J. Obst. & Gynec. **68**: 1174–1176, October 1954.

2. FALLS, F. H.: Uterus Arcuatus. Am. J. Obst. & Gynec. **38**: 661–670, October 1939.

3. FENTON, A. N., AND SINGH, B. P.: Pregnancy Associated with Congenital Abnormalities of the Female Reproductive Tract. Am. J. Obst. & Gynec. **63**: 744–755, April 1952.

4. JARCHO, J.: Malformation of the Uterus; Review of Subject, Including Embryology, Comparative Anatomy, Diagnosis and Report of Cases. Am. J. Surg. **71**: 106–166, January 1946.

5. HOFFMAN, E. S.: Uterus Didelphys and Its Clinical Significance in Pregnancy. Am. J. Obst. & Gynec. **51**: 692–698, May 1946.

SUMMARIO IN INTERLINGUA

Placentographia a Tessuto Molle in le Diagnose de Utero Bicornute

Es describite tres casos de utero bicornute in que le diagnose esseva suggerite per placentogrammas anteroposterior a tessuto molle. Istos monstrava un modificate presentation pelvic, con capite e corpore orientate verso un latere del abdomine, le sacro pendente, e le gambas separate ab le trunco e extendite verso le latere opposite del abdomine. Il se tracta de un postura simile al postura de un persona jacente in un hamaca. Quando le feto se trova in iste position, il es justificate suspicer le presentia de un utero bicornute.

Large Pneumothorax and Associated Massive Collapse of the Homolateral Lung Due to Intrabronchial Obstruction

A Case Report[1]

SIDNEY W. NELSON, M.D.[2]

STANDARD textbooks of physiology, radiology, and chest diseases contain good accounts of mediastinal shifts and other phenomena associated with either pneumothorax or atelectasis. No report, however, of the simultaneous presence of pneumothorax and massive pulmonary collapse (atelectasis) of the homolateral lung could be found in the literature. It can be readily appreciated that accurate diagnosis of both these conditions would allow the institution of proper therapy for each, whereas failure to recognize the massive collapse resulting from intrabronchial obstruction might cause unnecessary and dangerous delay in removal of the obstructing material. In a case recently encountered, the correct diagnosis was made preoperatively.

CASE REPORT

A 49-year old Negro male was admitted to Billings Hospital, Chicago, on March 4, 1955, with a history of sudden onset of epigastric pain three days earlier. Gastroduodenal x-ray studies revealed the presence of a shallow antral crater; the chest film was normal (Fig. 1). A subtotal gastric resection with a Hofmeister repair was performed on March 14. Except for hiccoughs, the first three days following operation were passed comfortably. Physical examination during this period revealed rhonchi and râles bilaterally, but after the second day the patient was up and about without complaints. During the fourth postoperative night, dyspnea

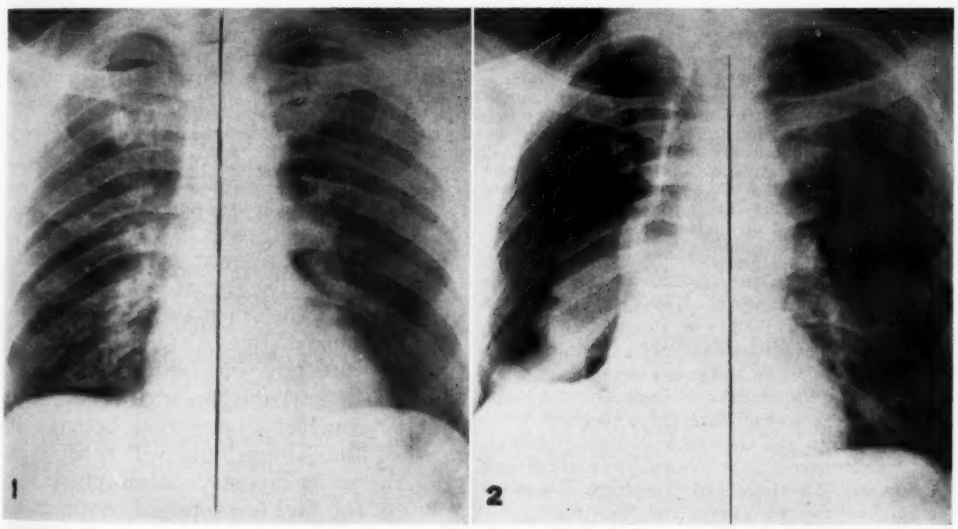

Fig. 1. Normal preoperative chest roentgenogram. Note the normal position of the mediastinal contents. In order to define the mid-line clearly for comparison with Fig. 2, a vertical line has been drawn through the vertebral spinous processes, which could be seen on the original film.

Fig. 2. Postoperative film. Note the large amount of intrapleural air on the right, the marked shift of the mediastinal contents to the right, the elevated right hemidiaphragm, and the slight crowding of the ribs on the right. The density of the collapsed lung is greater than is usually seen in retraction resulting from pneumothorax.

[1] This case report was prepared while the author was a member of the Radiology Staff at the University of Chicago. Accepted for publication in August 1956.

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and orthopnea suddenly developed. A chest film (Fig. 2) showed spectacular right pneumothorax with collapse of the right lung, which was displaced, with the mediastinum, toward the side of the pneumothorax. The diagnosis, on the basis of these findings, was "large negative-pressure right pneumothorax, with associated complete atelectasis of the right lung due to intrabronchial obstruction."

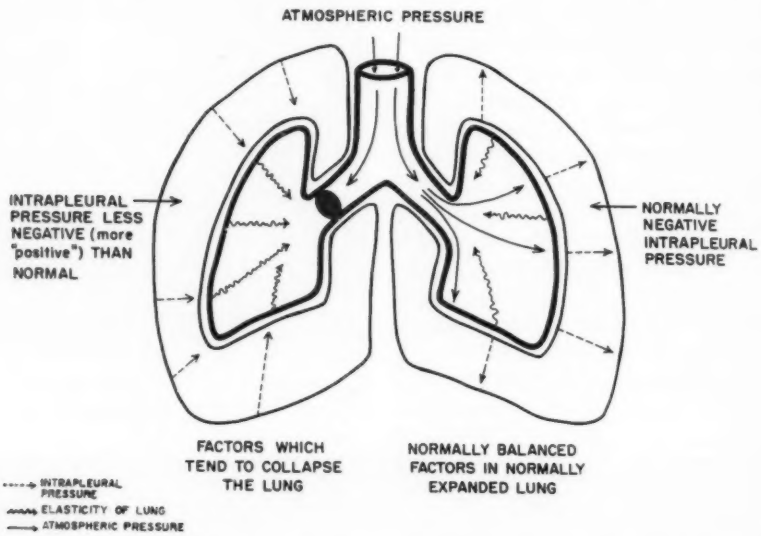
ATMOSPHERIC PRESSURE
INTRAPLEURAL PRESSURE LESS NEGATIVE (more "positive") THAN NORMAL
NORMALLY NEGATIVE INTRAPLEURAL PRESSURE
FACTORS WHICH TEND TO COLLAPSE THE LUNG
NORMALLY BALANCED FACTORS IN NORMALLY EXPANDED LUNG
INTRAPLEURAL PRESSURE
ELASTICITY OF LUNG
ATMOSPHERIC PRESSURE

Fig. 3. Diagrammatic illustration of factors which affect lung expansion or collapse. On the right the normal negative intrapleural pressure and the intrapulmonary atmospheric pressure keep the lung normally expanded by overcoming its elasticity. On the left it can be seen that either a complete bronchial obstruction followed by absorption of air distal to the obstruction, or a pneumothorax which diminishes the negativity of the intrapleural pressure, will allow the normal pulmonary elasticity to collapse the lung.

A large amount of thick, tenacious mucoid material was removed from the right mainstem bronchus through the bronchoscope. This procedure was repeated on subsequent days because re-accumulation of secretions prevented complete expansion of the lung, in spite of the institution of closed chest drainage following the radiologic diagnosis. Tracheotomy was done to facilitate the aspiration of the secretions from the trachea and mainstem bronchus. Subsequent improvement was rapid and continuous. The lung had completely expanded, the tracheotomy was closed, and chest suction was discontinued prior to discharge from the hospital on March 30. The roentgen appearance of the chest at that time was identical with the preoperative picture (Fig. 1).

DISCUSSION

Normally an equilibrium exists between the forces which tend to expand the lung and those tending to retract it (Fig. 3). The intrapulmonary atmospheric pressure, along with the negative intrapleural pressure, acts to maintain expansion, while the elastic recoil force of the lung tends to retract it toward the hilus. In pneumothorax the negative intrapleural pressure is diminished, allowing this elastic force fuller play. The heart and mediastinal contents are then displaced to the opposite side because of the greater negative intrapleural pressure on that side. On the other hand, when the air distal to a complete bronchial obstruction becomes absorbed, the airless lung will collapse and assume water density. Atmospheric pressure in the face of bronchial obstruction is no longer effective in maintaining expansion distal to the obstruction. The collapsed lung makes the intrapleural pressure more negative on the side of the atelectasis than on the side of the normally expanded lung, and the mediastinal contents therefore move toward the atelectatic side.

The preceding case was considered to be

of interest because of the radiologic recognition of these two separate entities occurring simultaneously in the same hemithorax. The large pneumothorax was obvious, and some casual observers felt that this in itself had allowed the lung to retract. However, the disconcerting shift of the entire mediastinum toward the side of the pneumothorax, accompanied by elevation of the right hemidiaphragm and crowding of the ribs on the right, made this diagnosis untenable. That the mediastinal shift was of recent development was indicated by the preoperative chest film (Fig. 1) in which the position of the mediastinum was perfectly normal, with no evidence of any chest lesion. It was also felt that the water density of the collapsed right lung was indicative of complete absorption of air distal to a bronchial obstruction rather than the result of retraction of lung due to pneumothorax. When all of the findings were correlated, it was considered imperative to emphasize the presence of the intrabronchial obstruction and to urge that the endobronchial obstruction and massive pneumothorax be treated simultaneously. Each of these two conditions is, in itself, an acute medical emergency requiring immediate treatment because of the sudden alterations in mediastinal physiology and pulmonary blood flow. The fact that the two produce opposite effects on intrapleural pressure and mediastinal movements demands that both be treated simultaneously, in order to bring about the most rapid return to normal.

SUMMARY

A case of massive pulmonary collapse (atelectasis) with homolateral massive pneumothorax has been presented. No similar case report was found, although this phenomenon has probably been observed elsewhere, particularly in large tuberculosis sanitariums, where therapeutic pneumothorax may occasionally be accompanied by lung collapse due to endobronchial disease of the homolateral lung.

The diagnosis of negative-pressure pneumothorax and massive collapse of the lung on the same side, as a result of endobronchial obstruction, can be accurately made on a radiologic basis alone, as in the present case.

Recognition of the condition as *atelectasis associated with pneumothorax* rather than *retraction of the lung due to the pneumothorax* may be lifesaving. Early diagnosis may prevent serious sequelae, since the two conditions can be treated concomitantly.

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REFERENCES

BEST, C. H., AND TAYLOR, N. B.: The Physiological Basis of Medical Practice. Baltimore, Williams & Wilkins Co., 6th ed., 1955.

RIGLER, L. G.: The Chest. A Handbook of Roentgen Diagnosis. Chicago, Year Book Publishers, 1946.

RITVO, M.: Chest X-ray Diagnosis. Philadelphia, Lea & Febiger, 1951.

RUBIN, E. H.: Diseases of the Chest: With Emphasis on X-ray Diagnosis. Philadelphia and London, W. B. Saunders Co., 1947.

SCHINZ, H. R., BAENSCH, W. E., FREIDL, E., AND UEHLINGER, E.: Roentgen-Diagnostics. First American edition (based on 5th German edition), edited by James T. Case. New York, Grune & Stratton, Vol. III, 1953.

SHANKS, S. C., AND KERLEY, P.: A Text-Book of X-Ray Diagnosis by British Authors. Philadelphia, W. B. Saunders Co., Vol. II, 1950.

WIGGERS, C. J.: Physiology in Health and Disease. Philadelphia, Lea & Febiger, 5th ed., 1949.

NORRIS, G. W., AND LANDIS, H. R. M.: Diseases of the Chest and the Principles of Physical Diagnosis. Philadelphia and London, W. B. Saunders Co., 6th ed., 1938.

SUMMARIO IN INTERLINGUA

Constatationes Radiologic in un Patiente con Extense Pneumothorace e Associate Collapso Massive del Pulmon Homolateral, Debite a Obstruction Intrabronchial

Es presentate un caso in que—post subtotal resection gastric—le roentgenogramma thoracic monstrava un massive pneumothorace dextere in coincidentia con collapso del pulmon dextere e displaciamento del mediastino verso le mesme latere. Esseva constatate que le dextere broncho principal esseva obstruite per un spisse massa mucoide. Post repetite aspirationes le pulmon se re-expandeva, e le

apparentia roentgenologic retornava al norma. Super le base de su observationes in iste caso, le autor conclude que le diagnose de pneumothorace a pression negative e collapso massive del pulmon homolateral como resultato de obstruction endobronchial pote esser establite per medios radiologic sol. Le prompte recognition del condition como atelectasis *associate con* pneumothorace plus tosto que retraction del pulmon *debite a* pneumothorace pote prevenir serie sequellas, proque alora le duo phenomenos associate pote esser tractate vigorose- e concomitantemente.

The A-V Lecture Kit[1]

WM. R. CHRISTENSEN, M.D., and ROBERT S. WARNER, M.D.[2]

WHILE THE desirability of continuing postgraduate education for all physicians is generally accepted, its implementation presents many problems. This is especially true in the case of the busy general practitioner who is isolated in a remote area and the demands of whose practice are such that extended periods of free time are a rarity. The Division of Postgraduate Medical Education of the College of Medicine, University of Utah, with the help of a grant from the Kellogg Foundation, has been actively investigating ways and means of attacking this situation for some years (2). Among the technics that have been tried are: (*a*) postgraduate lecture series; (*b*) rural seminars (on a county or regional basis); (*c*) open-circuit television clinics; (*d*) audio-visual kits (1). The last of these approaches has been singularly successful and appears to justify more extensive trial.

The following represents a brief summary of our experience with the first two audio-visual kits released. Both are concerned with radiological subjects, namely, "The Accuracy and Reliability of Radiological Diagnosis" and "Radiological Examination of the Chest."

No claim of priority or pre-eminence is made in regard to the technic. It is a well established educational tool. Our sole interest is in calling general attention to what appears to be a worthwhile but generally neglected approach to the teaching of postgraduate radiology.

The audio-visual kit itself consists of a single compact box weighing 23 pounds, measuring 18 × 18 inches and containing: (*a*) long-playing 33 1/3 rpm records of radiological discussion; (*b*) a script of the discussion, including slide cues; (*c*) 35-mm. slides prepared from Kodachrome transparencies; (*d*) a table-top viewer for the slides. The kit (Figs. 1) can be dispatched by parcel post or express without excessive expense. The total cost of the unit as pictured is approximately $140.00. The only equipment which must be supplied by the physician is an ordinary long-playing (33 1/3 rpm) phonographic pick-up.

From this description, the potentialities and purpose of the unit should be fairly clear. Briefly, a prepared lecture illustrated by pertinent radiographs is available at the convenience of the physician. Long periods of travel, absence from work, and loss of time are eliminated. The success of the approach represents a balance between the interest of the physician and the effectiveness of the technic.

The selection of subjects for the first two kits[3] was deliberately slanted toward discussions of a general and basic nature. It was felt that little accurate knowledge was available to the geographically isolated general practitioner concerning these subjects; yet he was continually required to solve problems related to them. Each was covered by a lecture approximately forty-five minutes in duration, in which all points were illustrated by clear-cut, classical radiographs. The discussion actually centered around and was wholly concerned with the description and consideration of thirty-five radiographic slides.

A period of approximately one year has elapsed since the audio-visual kits were first released. Each physician to whom a kit has been dispatched has been asked to return a brief questionnaire indicating his reaction to the unit. There can be little doubt of the fact that the kits were welcome and considered of real value. Eighty-

[1] From the University of Utah College of Medicine, Salt Lake City, Utah. Accepted for publication in June 1956.
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[3] An additional kit, "The Role of the PA Film of the Chest in Cardiology," has recently been prepared for the American Heart Association and over sixty of these units are being used in various parts of the United States today.

five of those replying to the questionnaire accompanying the first kit found it of "definite educational value"; 7 regarded it as of "some educational value," and 2 of little or none. Sixty-eight preferred it to other forms of postgraduate education (postgraduate course, rural seminar, open-circuit television), assuming comparable discussion. The 60 who replied to the questionnaire on the second kit were unanimous in considering it of educational value (57 "definite"; 3 "some"); 26 preferred it to the other forms of postgraduate study.

verse comments indicated that the subjects were either too general or were not fundamental enough. It is obvious that one could not dovetail in one kit the whole spectrum of medical education represented. This problem could be overcome only by preparing kits of varying complexity.

Five of the total group objected to the quality of the slides. This was unquestionably a legitimate complaint. The di-

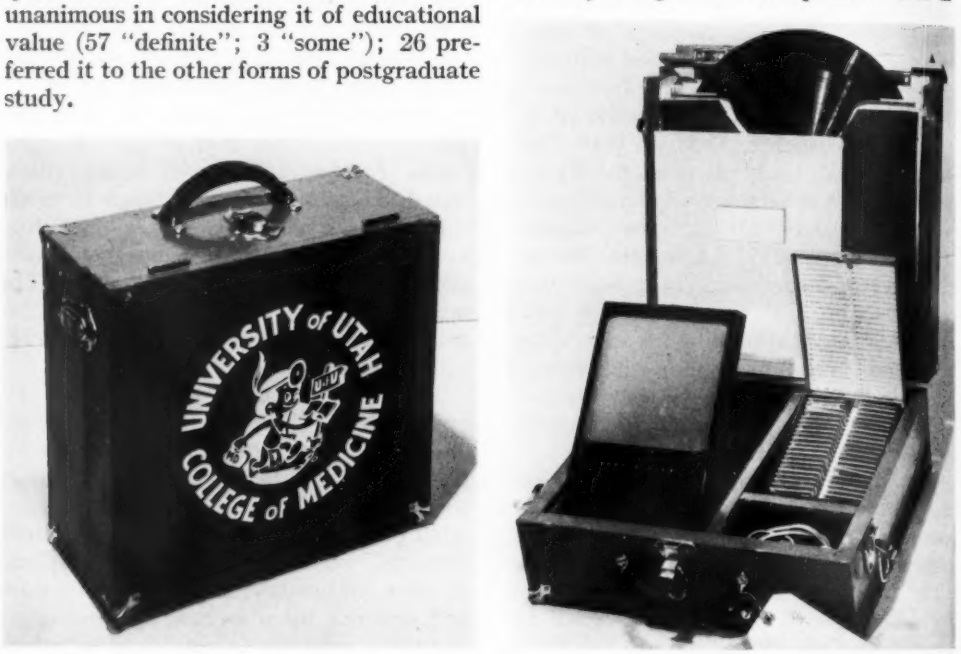

Fig. 1 Audio-visual kit for postgraduate instruction in radiology.

It is somewhat surprising that the A-V kit was considered as valuable as the usual postgraduate course. Analysis of the questionnaire gives some rationale for this finding. Physicians in urban areas where postgraduate courses were readily available preferred that medium, while those in remote and isolated sections were strongly in favor of the A-V technic.

Comments were solicited as part of the questionnaire. These varied widely. It was clearly apparent that the level of education markedly affected the enthusiasm of the viewer. The majority of the adrect positive Kodachrome transparencies display a deep blue tint quite unlike that seen in ordinary radiographs. Our relatively crude photographic equipment resulted in moderate loss of detail even in the original 35-mm. slide. When the initial transparency is subjected to mass reproduction, these two deficiencies are even more apparent. Much criticism was avoided by concentrating on gross and classical lesions. None of the discussion depended on clear visualization of fine detail. Reproduction of each transparency from the original film with the usual black

and white photographic technic would provide an obvious solution but at considerable added expense.

The great majority of comments were enthusiastic and appreciative. Several were accompanied by requests for all similar studies available.

SUMMARY

The audio-visual kit represents a valuable but little used means of postgraduate medical education. Radiological subjects can be well presented by this technic. Two kits prepared by the Division of Postgraduate Medical Education of the College of Medicine of the University of Utah, dealing with radiological subjects, have been enthusiastically received by physicians of the Intermountain Area.

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REFERENCES

1. WARNER, R. S.: New Audio-Visual Methods in Postgraduate Medical Education. J. Biol. Photographic A. **22**: 150–160, November 1954.
2. WARNER, R. S., AND BOWERS, J. Z.: Program of Postgraduate Medical Education. J.A.M.A. **160**: 1306, April 14, 1956.

SUMMARIO IN INTERLINGUA

Utensilario de Instruction Audio-Visual

Utensilarios audio-visual es de valor in le instruction medical de consecution, specialmente pro medicos in relativemente isolate territorios. Tal utensilarios ha essite preparate per le Division de Education Medical Consecutori del Schola de Medicina al Universitate Utah. Es presentate un breve summario del reaction evocate per le prime duo utensilarios concernite respectivemente con "Le Exactitude e Fidelitate del Diagnose Radiologic" e "Le Examine Radiologic del Thorace."

Le utensilario individual consiste de un sol cassa de un peso de pauco plus que 10 kg, mesurante 46 per 46 cm e continente (*a*) discos a micro-sulco (33 1/3 rpm) de discussiones radiologic, (*b*) le transcripto del discussiones, (*c*) diapositivas de 35 mm, preparate ab transparentias Kodachrome, e (*d*) un laminoscopio (modello de tabula) pro le diapositivas.

In general, le reception accordate a iste utensilarios ha essite favorabile. On ha recognoscite que illos es clarmente de valor educative. Le majoritate del personas qui ha usate los ha reportate que illes prefere le utensilarios a altere formas de instruction consecutori, per exemplo regular cursos post-diplomal, seminarios rural, e television a circuito aperte.

SUMMARIO IN INTERLINGUA

Puncta de Clysteres de Barium a Retention Automatic: Melioration

(*Vider le pagina sequente*)

Le autores describe un melioration del puncta de clysteres a barium del typo ballon a retention automatic in que le insertion es rendite plus facile per le introduction de un forte filo metallic (calibre no. 8, circa 3 mm de diametro) in quasi le complete extension del puncta. Isto elimina le perdita de tempore que es communmente associate con punctas del typo ballon a causa de lor mollitate e proque le ballon non passa facilemente per le sphincter anal. Il es importante que le puncta, con le filo inserite, es dirigite posteriormente pro evitar lesiones de tessuto.

Self-Retaining Barium-Enema Tip: Improvement[1]

WILLIAM SNOW, M.D., and JOHN C. HOLLINGSWORTH, R.T.

THE SELF-RETAINING balloon type enema tip is probably the most efficient means for preventing spilling in the course of a barium-enema examination. There is a tendency, nevertheless, to avoid its use because of the difficulty of insertion. The tip is soft and the balloon does not pass the anal ring with sufficient ease. Unless the operator wears gloves, his hands are soiled by the lubricant. Moreover, the maneuver frequently requires too much time. For these reasons, the following improvement was devised.

A stiff metal wire of number 8 gauge is inserted into the enema tip for almost its full length. This makes it possible to introduce the tip with no loss of time and eliminates the need of gloves. The end of the wire reaches to within an inch of the rubber tip, so that injury to the anus or rectum is avoided (Fig. 1).

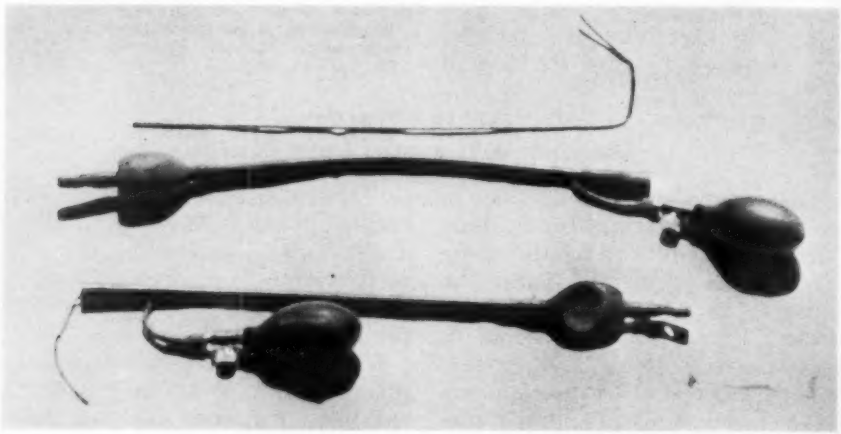

Fig. 1. Improved self-retaining barium enema tip.

The patient is placed on one side with the upper knee flexed. The upper buttock is lifted, exposing the anus. The operator inserts the well lubricated rubber tip for a short distance and then directs it posteriorly toward the hollow of the sacrum, using gentle pressure until the balloon has been passed beyond the internal sphincter of the anus. The wire is then removed. Once this has been accomplished, the balloon is distended with air and the barium enema may be introduced. It is important that the tip with the wire in place be directed posteriorly so as to avoid injury to tissues.

With this improvement, the self-retaining balloon tip for barium enemas is now used routinely in preference to other methods in the authors' institution.

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[1] From the Department of Radiology, Veterans Administration Center, Shreveport, La. Accepted for publication in August 1956.

(*Por le summario in interlingua, vider pagina 417*)

A Cranial Immobilization Device for Use in Roentgen Therapy[1]

BERNARD ROSWIT, M.D., CYPRIAN B. REID, B.Sc., and STANLEY J. MALSKY, M.A., M.Sc.

With the technical assistance of Louis Maddalone

IN ROENTGEN THERAPY of radiocurable cancer, there can be no excuse for a "geometric miss" caused by ineffective immobilization of the involved body part during the treatment period. The risk is greatest in mobile structures such as the head and neck, where malignant lesions are relatively small and often lie perilously close to such important normal structures as the eyes, brain stem, spinal cord, and mandible. In supervoltage and rotational therapy, with longer target-skin distance and more radical tumor dosage, the hazard of a "geometric miss" is aggravated. The success of *rotational* therapy, in particular, depends critically upon the absolute fixation of the tumor site within the axis of rotation throughout the period of irradiation.

There appears to be no commercially available apparatus which provides effective cranial immobilization under all treatment conditions, and especially for rotational technics. A device fulfilling these requirements was designed and fabricated in our Mold Room at moderate expense. The construction and application are illustrated in Figures 1 and 2. The device is adjusted easily and quickly to any patient with a head or neck lesion requiring roentgen therapy. Fixation is absolute and reproducible daily throughout the treatment schedule. This unit has been utilized in hundreds of cases over

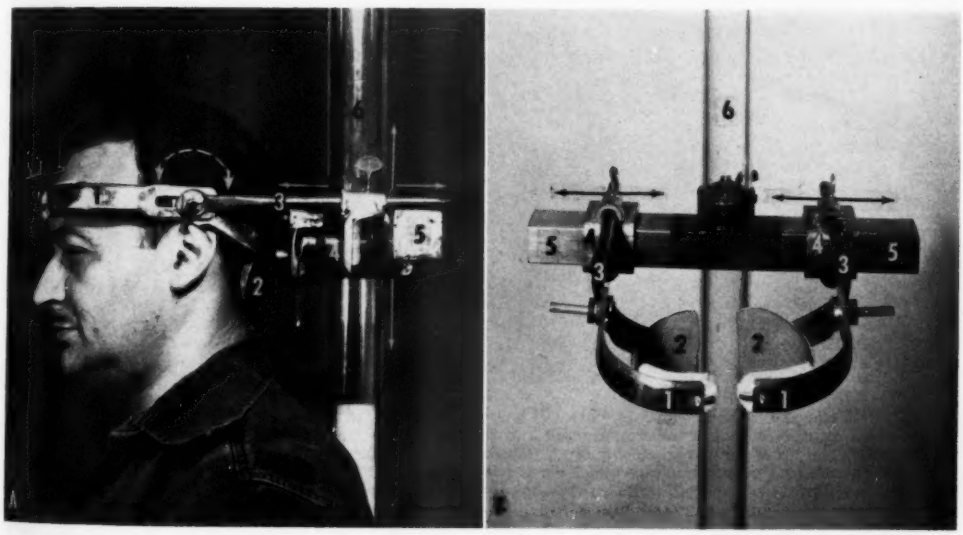

Fig. 1. Typical treatment settings for rotational therapy utilizing the cranial immobilization device. A and B. Adjustable bivalved steel yokes provide fixation for the brow (1) and for the occiput (2). They are slotted and joined to a pair of steel rods (3) by means of bolts and wing nuts, providing 180° rotation. The steel rods insert into receiver blocks (4) mounted on the cross-bar (5) attached to the vertical post (6). All lesions below and above the brow can be treated with this arrangement.

[1] From the Radiotherapy Service, Veterans Administration Hospital, Bronx, N. Y. Presented as an exhibit at the Forty-first Annual Meeting of the Radiological Society of North America, Chicago, Ill., Dec. 11–16, 1955. Accepted for publication in May 1956.

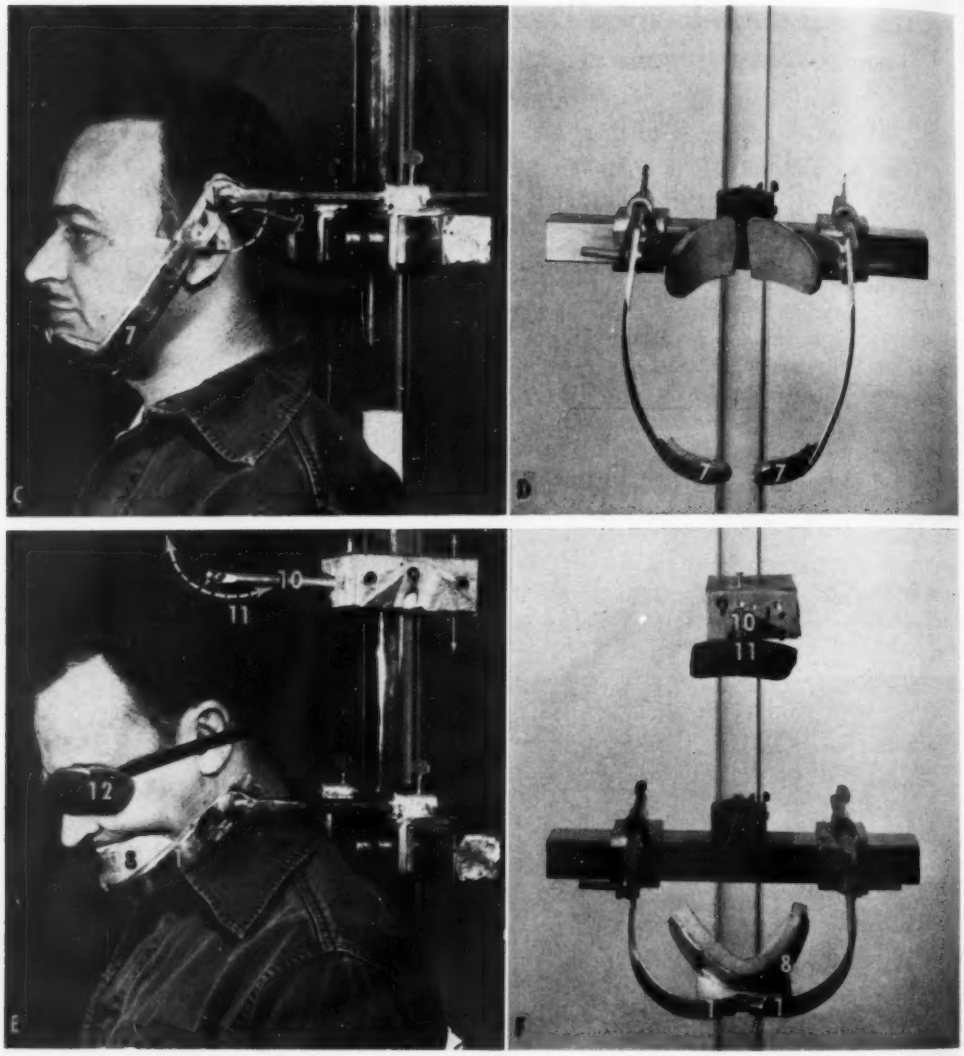

Fig. 1. C and D. A bivalved chin yoke (7) has been substituted for the brow yoke (1) to allow access to lesions in the anterior aspect of the cranial vault and the face.

E and F. The brow yoke (1) is now utilized to hold the chin, supplemented by an individualized chin cup (8) easily fabricated from plaster bandage and layered with thin sponge rubber or felt. Note the additional receiver block (9) to hold the steel rod (10) which supports the adjustable vertex plate. This is an ideal setting for treatment of pituitary and most intracranial lesions. For added security, a lead eyeshield (12) is sometimes worn by the patient.

the past two years and has proved to be eminently satisfactory in clinical practice. It can be attached without difficulty to the cross-bar of rotational equipment now in general use or to conventional treatment chairs for fixed portal technics.

VA Hospital
130 W. Kingsbridge Rd.
Bronx 68, N. Y.

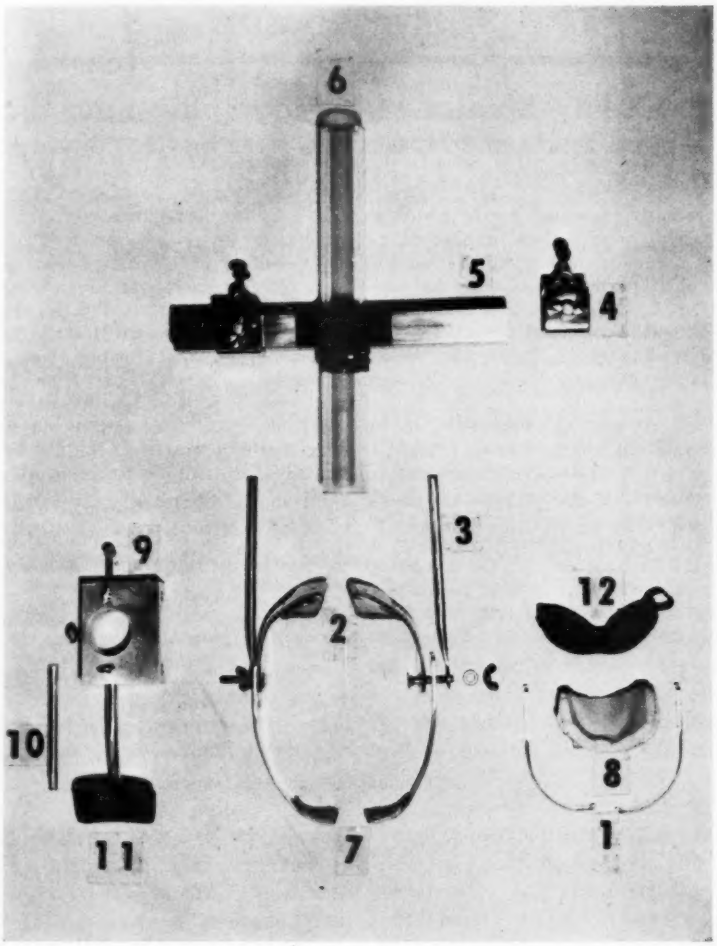

Fig. 2. Exploded view of cranial immobilization device, illustrating all component parts. Note (1) brow yoke, (2) occipital yoke, (3) steel supporting rods, (4) receiver blocks, (5) cross-bar of rotational chair, 6) vertical post, (7) chin yoke, (8) individualized chin cup of plaster bandage, (9) receiver block for vertex plate, (10) steel supporting rod for vertex plate, (11) vertex plate, (12) protective lead eye shield.

SUMMARIO IN INTERLINGUA

Un Dispositivo de Immobilisation Cranial pro le Uso in Roentgenotherapia

Es describite un dispositivo pro le efficace immobilisation cranial sub omne conditiones e specialmente in technicas rotational. Per medio de illo le fixation es absolute e reproducibile de die a die durante le integre periodo del tractamento. Le elemento distinctive consiste de adjustabile jugos bivalve de aciero que provide fixation pro occipite, fronte, e mento. Le dispositivo pote esser attachate sin difficultate al barra transversal de apparaturas rotational nunc in uso o a sedes de tractamento conventional pro technicas a portal fixe.

X-Ray Studies of Photographic Film

NATIONAL BUREAU OF STANDARDS, U. S. DEPARTMENT OF COMMERCE

Experiments recently performed by the National Bureau of Standards provide data on the photographic response of commercial x-ray films at unusually high rates of exposure.[1] The work was supported by the U. S. Atomic Energy Commission and the U. S. Army Signal Corps, and the experiments were conducted by Margarete Ehrlich and W. L. McLaughlin of the Bureau's Radiation Physics Laboratory.

Earlier investigators used exposure rates up to about 60 r per second, and a ratio of lowest to highest exposure rates of 1 to 10,000. The exposure rates used in the Bureau's experiments extended to about 1,100 r/sec, with a ratio of lowest to highest rates of .1 to 30,000. The results confirm the validity of the reciprocity law for exposures on the ascending branches of the characteristic curves of two widely used commercial x-ray films, over the exposure-rate range covered in the experiment. The results also establish the failure of the reciprocity law in the reversal region of the characteristic curve of one of the two film types over the same exposure-rate range.

A satisfactory interpretation of the basic mechanisms involved must await further experimentation. The results of investigations at the Bureau and elsewhere suggest that further clarification of these problems could be expected from experiments both with visible light and with x-rays or high-energy electrons, with exposure-rate intervals wider than those hitherto employed. Plans for further work in this direction are under consideration by the Bureau.

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[1] For further technical details, see Ehrlich, M., and McLaughlin, W. L.: The Reciprocity Law for X-rays. Part I: Validity for High-Intensity Exposures in the Negative Region; Part II: Failure in the Reversal Region. J. Opt. Soc. Am. **46**: 797 and 801, October 1956.

EDITORIAL

Attitudes in Radiology

Presidential Address: Radiological Society of North America[1]

With more than usual discernment, a recent speaker on labor relations made the comment that, "although great progress has been made in general working conditions, there is still much to be desired in mutual attitudes." A similar statement might well be made in the field of medicine and, indeed, in the specialty of radiology. Fabulous scientific accomplishments have in no way lessened the daily socio-economic problems which are, to a large degree, matters of attitude.

Radiologist-Patient Relationship: As practitioners of medicine, radiologists are increasingly faced with problems of human relationships and behavior which all too frequently are met with inadequate responses. The sacred patient-physician relationship, which has been so stressed in recent years, must still be guarded most religiously in our daily practice if its significance is to be maintained. The pressures of modern medical practice, as encountered in the field of radiology, continuously infringe on the time available for expression of personal interest in our patients.

The increasing versatility of radiological procedure has steadily tipped the balance toward the science side of medical practice at the expense of the art of the profession. Having made this analysis, one is forced to inquire: "Is this bad?" The value of radiology as a medical science can be measured only in its application to the curing of the ills of humanity. This concept must be retained in the training of those who would practice radiology if it is to remain a specialty of medical practice. The zeal of our forebears in protection of the public against the charlatanism of mere picture making will have come to naught if the warmth of medical art is lost to our specialty.

Enumeration of the multiple factors in present radiological practice that serve to detract from its status as an art is beyond the scope of this discourse. It remains only to point out that the many inroads being made on private medical practice, of social and economic origin, must make us ever more cognizant of our obligations to the patient. The radiologist who considers himself a medical clinician must exercise the functions of a clinician. In no sense does meticulous care in radiographic procedures lessen his clinical obligations. It is, indeed, this very fidelity to detail that enhances his value as a clinician.

This philosophy has been highlighted in a recent commercial advertisement in which the patient is represented as asking his doctor, "What is a radiologist?", and receiving the reply, "He is a physician just as I am. X-ray is his specialty (1)." Again, the theme receives timely emphasis in a new film sponsored by the Commission on Public Relations of the American College of Radiology, "First a Physician." It is this attitude on the part of the radiologist that sets him apart from the "picture maker," from the mere owner of an x-ray machine, from the technician, and gives him something of the stature of a true clinician.

[1] Delivered at the Forty-second Annual Meeting, Chicago, Ill., Dec. 2–7, 1956.

It is this concept of the radiologist at his best which prompted one observer to remark: "One might say that diagnostic radiologists are doctors to doctors and your diagnoses will have to stand up under the cold scrutiny of your peers rather than the trusting innocence of your patients (2)." The full import of this observation will have significance only to the radiologist who, by his painstaking attention to radiographic detail and careful interpretation, commands the respect of his confreres and assumes the clinical status that is his heritage. The rich rewards of personal satisfaction and the esteem of one's fellow practitioners can come only to him who strives to think of himself always as a clinical consultant.

In making the foregoing statements, I am not unmindful of those in the practice of our specialty who look somewhat askance at the diagnostic radiologist who contends that the art of medicine has anything but a minor place in diagnostic radiology. To maintain this thesis, even in the light of the tremendous technical advances of recent years, seems to this observer to be simply "short selling" the practitioners of modern diagnostic radiology. Happily, I believe this is a minority view.

Implied in this negative attitude is the thesis that therapeutic radiology offers boundless opportunity to practice and display the art of medicine to its ultimate glory. With this we have no disagreement. Dr. U. V. Portmann, himself a renowned radiation therapist, once said: "The therapeutic radiologist must be a physicist, pathologist, clinician, and surgeon to practice his art of medicine (3)."

The term clinician in this reference calls for special attention In therapeutic radiology, the attributes of the clinician must not only include a large measure of clinical judgment but must involve also the much stressed physician-patient relationship. The radiation therapist who, having considered the pathological problem presented and laid out his plan of attack accordingly, proceeds to administer it without having carefully interviewed his patient and prepared him—or her—psychologically for what may be an ordeal, may do a great disservice to therapeutic radiology and even utterly fail in attaining a possible good result.

Preparation of the patient for a planned procedure must establish confidence in his mind both as to the integrity of the therapist and the need of therapy in the particular situation under consideration. Such preparation will frequently demand the greatest diplomacy on the part of the consultant, if a mutual patient-physician attitude is to be established which will stimulate co-operation. In this connection much has been written about the need for or moral obligation of exact truth telling. I commend to you a recent compilation of views expressed by physicians, nurses, clergymen, and lawyers on this subject, under the title, "*Should the Patient Know the Truth?*", edited by Samuel Standard and Helmuth Nathan (4).

In any particular situation, the wisdom of evasion or frank admission of the truth must depend on the best judgment of the physician under the circumstances. There can be no hard and fast rule, nor any uniformly pat answer, unless it is, "I don't know." This admission, however, is a shallow refuge when ignorance is vincible and might have been overcome by knowledge kept abreast of progress. On the other hand, the patient's confidence will rarely be stimulated by an attempt to convey a sense of omniscience. An attempt to impress the patient results more often in distrust.

Radiologist-Physician Relationship: The concern which the radiologist should have about his status as a clinician, touched on in the foregoing paragraphs, is no less than the concern which should be his in regard to his position as a medical consultant. The not infrequent jibe in medical circles, "I wish *I* were a radiologist," may well indicate a deep resentment of the radiologist's way of life and deserves at least a modicum of attention and analysis. There may be, in the back-

ground, a feeling that radiologists actually do not work as hard as their fellow practitioners and that radiologists' fees are exorbitant in relation to the contribution which they make to the solution of most clinical problems. Accompanying this attitude there may exist a studied attempt to detract from the radiologist's stature as a consultant in the eyes of the patient by failing to quote his report of the requested examination. The impersonal character of this procedure may often be enhanced by the lack of interest on the part of the radiologist in the problem which confronts the referring physician and failure to attempt to assume the role of a true consultant.

Such an attitude is not conducive to a healthy co-operative relationship and can only redound to the detriment of the patient. Conversely, when full advantage is taken of radiological facilities and radiological knowledge, there is mutual benefit to patient, referring physician, and the radiologic consultant. This ideal situation may seem to many to be little more than wishful thinking. However, a determined effort by the radiologist to keep uppermost in his mind, in every examination, his function as a consultant will go a long way in bringing this about.

Radiologist-Hospital Relationship: The expanding potentialities of radiology as a profession demand a greater and greater dependence on hospitals. This is a mutual dependence. The increased facilities and services which modern hospitals are offering patients may seem to some to make them less dependent on their medical staffs. It is from this sense of self sufficiency that much of the strife and difficulty between hospitals and radiologists has arisen. The falseness of this concept of self sufficiency rests in the fact that medical services are considered a commodity on which a profit may be realized. Profit rather than service then becomes the first consideration. In contradistinction to the situation where profit is the motive, radiological service will improve when there is no intervening third party.

Any device which impairs the objective of good medical service undermines the foundation of medicine as a profession. In radiology, contractual agreements with the hospitals are necessary arrangements for the dispensing of their services. When both parties look upon the contract as a means to this end, the quality of medical service is certain to improve.

In summarizing the thoughts expressed here, which have to do with the attitude of the radiologist to his patient, to his fellow practitioner, and to the hospital in which he works, a quotation from an address by Sir William Osler to his students seems appropriate: "After all, the attitude of mind is the all-important factor in the promotion of concord (5)."

CLARENCE E. HUFFORD, M.D.

REFERENCES

1. General Electric advertisement. Newsweek, Feb. 13, 1956.
2. KIMPTON, L. A., Chancellor, University of Chicago: Address of Welcome, American Roentgen Ray Society, September 1955.
3. PORTMANN, U. V.: Therapeutic Radiology as a Specialty. Am. J. Roentgenol. 1–5, January 1950.
4. STANDARD, S., AND NATHAN H. M. (editors): Should the Patient Know the Truth? New York, Springer Publishing Co., 1955.
5. OSLER, SIR WILLIAM: Aequanimitas. Chapter XXI, Unity, Peace and Concord.

ANNOUNCEMENTS AND BOOK REVIEWS

GREATER MIAMI RADIOLOGICAL SOCIETY

At a meeting of the Greater Miami Radiological Society, on Jan. 16, 1957, the following members were elected to office: Edward F. Zimmerman, M.D., Coral Gables, President; Joseph Galluccio, M.D., Miami, Vice-President; George P. Daurelle, M.D., Jackson Memorial Hospital, Miami 36, Fla., Secretary-Treasurer.

GREATER SAINT LOUIS SOCIETY OF RADIOLOGISTS

Newly elected officers of the Greater Saint Louis Society of Radiologists are: President, Edwin C. Ernst, Jr., M.D., St. Louis; Vice-President, Sam J. Merenda, M.D., Glendale; Secretary-Treasurer, Thomas F. Maher, M.D., 634 N. Grand Blvd., St. Louis, Mo.

ROCHESTER ROENTGEN RAY SOCIETY

The Rochester (New York) Roentgen Ray Society has elected the following officers to serve for the coming year: President, Dr. A. Gordon Ide; Vice-President, Dr. Sawyer Gliddon; Secretary-Treasurer, Dr. John W. Colgan, 277 Alexander St., Rochester 18.

ROCKY MOUNTAIN RADIOLOGICAL SOCIETY

Announcement is made of the annual midsummer meeting of the Rocky Mountain Radiological Society, to be held in Denver at the Shirley-Savoy Hotel, Aug. 15–17, 1957.

ASSOCIATION OF RADIOLOGISTS OF THE PROVINCE OF QUEBEC

Recently elected officers of the Association of Radiologists of the Province of Quebec are as follows: Albert Jutras, M.D., President; Donald McRae, M.D., Vice-President; Isadore Sedlezky, M.D., 3755 Cote St. Catherine Rd., Montreal, Quebec, Secretary; Ivan Vallée, M.D., Treasurer.

RADIATION RESEARCH SOCIETY

The Annual Meeting of the Radiation Research Society will be held in Rochester, N. Y., on May 13–15, 1957. In addition to submitted papers, two symposia will be presented, one on radiation genetics and the other on radiation chemistry. There will be a series of invited lectures, the topics and speakers to be announced. Those wishing further information or to report original research on radiation effects may address the Secretary of the Society, Dr. A. Edelmann, Nuclear Science and Engineering Corporation, P.O. Box 10901, Pittsburgh 36, Penna.

SECOND INTERNATIONAL CONVENTION OF X-RAY TECHNICIANS

The Second International Convention of X-Ray Technicians, sponsored by the American Society of X-ray Technicians and the Canadian Society of Radiological Technicians, will be held at the Sheraton Park Hotel, Washington D. C., June 8–13, 1957. Further information may be obtained from the Chairman of the Publicity Committee, Leslie A. Majors, R.T., 5710 Newton St., Cheverly, Md.

FREEDMAN LECTURES UNIVERSITY OF CINCINNATI

On Saturday and Sunday, April 13 and 14, 1957, Dr. John A. Campbell, Chairman of the Department of Radiology, Indiana University Medical Center, will deliver the Ninth Annual Joseph and Samuel Freedman Lectures in Diagnostic Radiology at the University of Cincinnati College of Medicine. Radiologists desiring to attend should write Dr. Benjamin Felson, X-ray Department, Cincinnati General Hospital, Cincinnati 29, Ohio, for further details.

RADIOLOGIC PHYSICS COURSE COLUMBIA UNIVERSITY

The College of Physicians and Surgeons of Columbia University announces a course in radiologic physics, leading to the degree of Master of Science, to be given during the academic year 1957–58. This is a full-time, integrated course, including lectures, seminars, conferences, and laboratory work, with a Faculty composed of members of the Department of Radiology. Drs. Quimby, Rossi, Rugh, Braestrup, Feitelberg, and Gross will cover different phases of radiologic physics and radiobiology, while Drs. Seaman and Kligerman will present clinical applications. Practical laboratory work will be stressed, a large number of experiments being planned to cover all aspects of the course.

Prerequisite for admission is a bachelor's degree with a major or strong minor in physics, or equivalent scholastic background, with a good academic record. Tuition for the complete course is $900.

Inquiries may be directed to Dr Edith H. Quimby or Dr. Harald H. Rossi, 630 W. 168th St., New York 32, N. Y.

RADIOIODINE COURSE GEORGETOWN UNIVERSITY

A one-week intensive course in the "Diagnostic Use of Radioiodine (I-131)" will be given March 18–22, 1957, at Georgetown University Medical

Center, Washington, D. C. This course, open to authorized physicians, will meet Atomic Energy Commission requirements for the diagnostic use of I^{131}. Further information may be obtained from Dr. B. J. Duffy, Jr., Georgetown University Hospital, Washington 7, D. C.

RADIOISOTOPES COURSE COOK COUNTY HOSPITAL, CHICAGO

A course in the clinical use of radioactive isotopes will be given by I. F. Hummon, M.D., and Robert S. Lindauer, Ph.D., at the Cook County Hospital, May 6–17, 1957 (Monday through Friday), 9 to 12 A.M and 1 to 4 P.M.

This is a full-time course, including lectures, demonstrations, laboratory periods, clinics, and selected motion pictures. Lectures will cover radiation physics, radiation hazards and protection, natural and artificial radioactivity, theory of measurement, and counters and statistics. Clinical subjects will include the preparation, administration, and uptake of tracer materials, thyroid physiology, thyroid neoplasms, blood dyscrasias, blood-volume studies, and various uses of I^{131}, P^{32}, and Au^{198}. Atomic Energy Commission requirements and the obtaining of radioactive isotopes will be discussed.

Enrollment will be limited to fifteen students. The fee for the course is $200. Inquiries may be addressed to the Registrar of the Cook County Graduate School of Medicine, 707 S. Wood St., Chicago 12, Ill.

RADIOLOGICAL PHYSICS FELLOWSHIP SLOAN-KETTERING DIVISION CORNELL MEDICAL COLLEGE

Applications are invited for matriculation commencing in the Fall of 1957 in the graduate radiological physics program in the Sloan-Kettering Division of Cornell University Medical College. The program includes training in various aspects of implant dosimetry, treatment planning, calibration and measurement of different energies of x-rays and electrons, radioisotope handling, diagnostic and therapeutic aspects of radioisotope use, and radiation protection procedures. This training, with other courses and a thesis problem, constitute the primary requirements for the master of science degree. Fellowship aid covering living expenses and tuition is available. For further information, address Dr. John S. Laughlin, Department of Physics, Memorial Center, New York 21, N. Y.

RADIOACTIVE ISOTOPES COURSE UNIVERSITY OF SOUTHERN CALIFORNIA

The University of Southern California School of Medicine, Postgraduate Division, is conducting a course in The Physics and Clinical Applications of Radioactive Isotopes at the Los Angeles County and Cedars of Lebanon Hospitals on Friday afternoons from 4 to 5 P.M., from March 1 through July 12, 1957. It is intended to provide practical material for physicians wishing to secure the clinical training required for certification by the Atomic Energy Commission, as well as for those not planning to apply for certification, but wishing to increase their knowledge of the possibilities of radioactive isotopes. The course is under the direction of Henry L. Jaffe, M.D., Associate Clinical Professor of Radiology (Therapeutic) of the Department of Radiology of the Cedars of Lebanon Hospital, and Herman R. Haymond, Ph.D., Assistant Professor of Radiology (Physics) of the Department of Radiology of the Los Angeles County General Hospital. Further information may be obtained from Phil R. Manning, M.D., Director, Postgraduate Division, School of Medicine, University of Southern California, 2025 Zonal Avenue, Los Angeles 33, Calif.

CLINICAL FELLOWSHIPS AMERICAN CANCER SOCIETY

The American Cancer Society announces that its program of Clinical Fellowships will continue through the institutional year July 1, 1958–June 30, 1959, with Fellowships commencing July 1, 1958. A limited number of Fellowships are offered to institutions whose postgraduate training programs are approved by the Council on Medical Education and Hospitals of the American Medical Association. These Fellowships offer graduates in medicine opportunities for postgraduate training, emphasizing the diagnosis and treatment of cancer. Applications from institutions for the year 1958–59 must be submitted by Deans, Executive Officers, or Department Heads prior to April 15, 1957.

A limited number of Fellowships in Radiation Therapy are also offered in 1958–59 to properly qualified graduates in medicine who have already received thorough basic training in the principles and practice of radiation therapy and who would like to spend additional periods of training in that specialty at certain clinics in the United Kingdom, the Scandinavian countries, and France. Fellowships may begin at any time mutually agreeable to the institution and the fellow. The deadline for receipt of applications for these Fellowships is April 15, 1957.

Further information may be obtained from the Director of Professional Education, American Cancer Society, Inc., 521 W. 57th St., New York 19, N. Y.

PUBLIC HEALTH TRAINEESHIPS

The United States Public Health Service announces a continuation of its program of Public Health Traineeships for professional health personnel, including radiological and health physics. Stipends covering living expenses for the trainee and legal dependents, as well as tuition and related costs, are included in the traineeship awards. The

academic degree held by the individual determines the basic stipend level. The annual (twelve months) amounts range from $2,400 to $4,800, plus allowances for dependents and tuition.

The choice of an educational institution which offers a nationally recognized graduate or specialized public health training program in his field rests with the trainee and it is his responsibility to make all necessary arrangements with that institution, and to be accepted for training, before his application can be considered by the Public Health Service.

Application forms and additional information may be obtained from the Chief, Division of General Health Services, Bureau of State Services, Public Health Service, Washington 25, D. C., or from any regional office of the Public Health Service.

PROFESSIONAL GROUP ON MEDICAL ELECTRONICS INSTITUTE OF RADIO ENGINEERS NEW "AFFILIATE" PLAN

Physicians, biologists, physicists, and biophysicists are invited to participate in the Professional Group on Medical Electronics activities through an "affiliate" plan recently announced. The "affiliate" will not be a member of the Institute of Radio Engineers and therefore will pay only a reduced fee. He will receive notice of all local and national meetings and, in addition, will receive the *Newsletters* and *Transactions* of the group.

The aim is to bring together doctors, electronic engineers, biologists, and biophysicists to discuss the use of electronic technics in problems of medicine and biology. For further information address Mr. L. G. Cumming, Technical Secretary, Institute of Radio Engineers, Inc., 1 E. 79th St., New York 21, N. Y.

Books Received

Books received are acknowledged under this heading, and such notice may be regarded as recognition of the courtesy of the sender. Reviews will be published in the interest of our readers and as space permits.

THE YEAR BOOK OF RADIOLOGY (1956–57 YEAR BOOK SERIES). RADIOLOGIC DIAGNOSIS, edited by JOHN FLOYD HOLT, M.D., Professor, Department of Radiology, University of Michigan, and FRED JENNER HODGES, M.D., Professor and Chairman, Department of Radiology, University of Michigan. RADIATION THERAPY, edited by HAROLD W. JACOX, M.D., Professor of Radiology, College of Physicians and Surgeons, Columbia University, and Chief, Radiation Therapy Division, Radiologic Service, Presbyterian Hospital, New York City, and MORTON M. KLIGERMAN, M.D., Associate Professor of Radiology, College of Physicians and Surgeons, Columbia University, and Associate Attending Radiologist, Presbyterian Hospital, New York City. A volume of 430 pages, with 361 figures. Published by the Year Book Publishers, Inc., 200 East Illinois Street, Chicago, Ill. Price $9.00.

CLINICAL USE OF RADIOISOTOPES. By WILLIAM H. BEIERWALTES, M.D., Associate Professor of Internal Medicine and Coordinator, Clinical Radioisotope Unit, University Hospital, Ann Arbor; PHILIP C. JOHNSON, M.D., Assistant Professor of Internal Medicine and Chief, Radioisotope Unit, Veterans Administration Hospital, University of Oklahoma Medical School, Oklahoma City; ARTHUR J. SOLARI, B.S., M.S. (Physics), Instructor in Radiation Physics, Department of Radiology, Radiation Physicist for Clinical Radioisotope Unit and Kresge Research Isotope Unit, University Hospital, Ann Arbor. A volume of 456 pages, with 126 figures. Published by W. B. Saunders Co., Philadelphia & London, 1957. Price $11.50.

PEDIATRIC CARDIOLOGY. By ALEXANDER S. NADAS, M.D., F.A.A.P., Assistant Clinical Professor of Pediatrics, Harvard Medical School; Cadiologist, The Children's Hospital; Physician, Sharon Cardiovascular Unit, Children's Medical Center, Boston. A volume of 588 pages, with 343 figures. Published by W. B. Saunders Co., Philadelphia & London, 1957. Price $12.00.

THE PHYSICIAN-WRITER'S BOOK. TRICKS OF THE TRADE OF MEDICAL WRITING. By RICHARD M. HEWITT, A.M., M.D., Senior Consultant, Section of Publications, the Mayo Clinic; Associate Professor of Medical Literature, the Mayo Foundation, Graduate School, University of Minnesota. A volume of 416 pages, with 37 figures, and numerous tables. Published by W. B. Saunders Co., Philadelphia & London, 1957. Price $9.00.

HANDBOOK OF BIOLOGICAL DATA. Edited by WILLIAM S. SPECTOR. Prepared under the Direction of the Committee on the Handbook of Biological Data, Division of Biology and Agriculture, National Academy of Sciences—National Research Council. WADC Technical Report 56-273; Astia Document No. AD 110501, Wright Air Development Center, Dayton, Ohio. A volume of 584 pages. Published by W. B. Saunders Co., Philadelphia & London, 1956. Price $7.50.

RARE EARTHS IN BIOCHEMICAL AND MEDICAL RESEARCH: A CONFERENCE SPONSORED BY THE MEDICAL DIVISION, OAK RIDGE INSTITUTE OF NUCLEAR STUDIES, OCTOBER 1955. Edited by GRANVIL C. KYKER and ELIZABETH B. ANDERSON. A paper bound volume of 468 pages available from the Office of Technical Services, De-

partment of Commerce, Washington 25, D. C., 1956. Price $2.20.

LES ÉCRASEMENTS THORACIQUES. By JEAN GARBAY, MICHEL GARBAY, and CLAUDE VANDERPOOTEN. Preface by Dr. Sauvage. A monograph of 132 pages, with 12 roentgenograms. Published by Masson & Cie, 120, Boulevard Saint-Germain, Paris-6e, 1956. Price 1.100 fr.

Book Reviews

CLINICAL ROENTGENOLOGY. VOLUME IV. THE DIGESTIVE TRACT, THE GALL BLADDER, LIVER AND PANCREAS, THE EXCRETORY TRACT AND SPECIAL STUDIES EMPHASIZING DIFFERENTIAL CONSIDERATIONS. By ALFRED A. DE LORIMIER, M.D., Radiologist, Saint Francis Memorial Hospital, San Francisco, California; Consultant in Radiology for the United States Army, at the Letterman Army Hospital; Consultant in Radiation Therapy for the United States Public Health Service at the U. S. Marine Hospital, San Francisco; Former Commandant, The Army School of Roentgenology; HENRY G. MOEHRING, M.D., Radiologist, Duluth Clinic, Duluth, Minnesota; Former Director, The Army School of Roentgenology; and JOHN R. HANNAN, M.D., Radiologist, Cleveland, Ohio, and Lake County Memorial Hospital, Painesville, Ohio; Former Director, The Army School of Roentgenology; Associate Professor of Diagnostic Roentgenology, the Frank E. Bunts Educational Institute, Cleveland Clinic Foundation; Department of Roentgenology, Cleveland Clinic Foundation. A volume of 700 pages, with 1,112 illustrations. Published by Charles C Thomas, Springfield, Ill., 1956. Price $24.50.

The three previous volumes of this series on Clinical Roentgenology have been reviewed in earlier issues of Radiology (**62:** 597, 1954; **64:** 276, 1955; **66:** 281, 1956). Volume IV is devoted to the abdomen, covering in detail the gastrointestinal tract, the gallbladder and biliary tract, the urinary tract, obstetrical roentgenology, and gynecological roentgenology.

The general plan of the text follows that employed in the earlier volumes, the various conditions being discussed under the subheadings General Considerations, Roentgen Manifestations, Clinical Corroboration, and Differential Diagnosis. The descriptive material is brief and systematic, and is illustrated by roentgenograms, carefully selected and well reproduced, in the negative phase. Each chapter carries its own list of references.

This volume will be of immense value to students and practitioners who wish a concise, systematic description of abdominal lesions from the roentgen point of view.

RADIOLOGY OF THE ALIMENTARY TRACT IN INFANCY. By ROY ASTLEY, M.B., M.R.C.S., D.M.R., Radiologist. The Children's Hospital, Birmingham (United Birmingham Hospitals), England; Clinical Lecturer in Radiology and Lecturer in Radiological Anatomy, University of Birmingham. A volume of 288 pages, with figures, tables, and numerous roentgenograms. Published by Edward Arnold Ltd., London, and Williams & Wilkins Co., Baltimore, 1956. Price $10.00.

This is a timely textbook which has no exact counterpart in the literature, being especially concerned with examination of the digestive tract during the first year of life, although occasionally carrying over into the early years of childhood.

The text is divided into seven parts, as follows: (1) Esophagus; (2) Diaphragm; (3) Stomach; (4) Duodenum; (5) Small Intestine and Peritoneum; (6) Colon; (7) Miscellaneous. In these sections the author presents a general consideration of area problems followed by the radiologic technic and diagnostic features. Case reports with appropriate illustrations are included. A bibliography of pertinent references is given at the end of each chapter.

This small volume is a welcome addition to the medical literature. It should appeal to the radiologist and his resident staff, and will be of interest also to the pediatrician. The index, unfortunately, is not as complete as one might wish.

PROCEEDINGS OF THE INTERNATIONAL CONFERENCE ON THE PEACEFUL USES OF ATOMIC ENERGY. HELD IN GENEVA 8 AUGUST–20 AUGUST, 1955. VOL. 10: RADIOACTIVE ISOTOPES AND NUCLEAR RADIATIONS IN MEDICINE. A volume of 544 pages, with numerous tables and illustrations. VOL. 11. BIOLOGICAL EFFECTS OF RADIATION. A volume of 402 pages, illustrated. Published by the United Nations, New York, 1956. Distributed in United States by Columbia University Press, New York. Price $8.00 per volume.

The papers presented at the International Conference on the Peaceful Uses of Atomic Energy, Geneva, 1955, together with the "Record of the Conference," occupy sixteen large volumes. The two listed above are the ones of chief interest to the clinical radiologist. It is manifestly impossible here to do more than indicate the scope of their contents.

Volume 10 comprises 84 papers on radioactive isotopes and nuclear radiations as presented in four sections. The first four contributions are drawn from the Section on Isotopes in Technology and Industry and constitute a sort of introduction to the papers of the remaining Sections devoted to Therapy and Diagnosis and Studies of Disease.

The 63 papers of Volume 11 are similarly grouped according to the Sections in which they were presented. Among the subjects covered are modes of radiation injury, carcinogenesis and metabolism of

bone-seeking isotopes, effects on the reproductive system and on the fetus, mechanisms of injury, protection and recovery, and genetic effects and their human implications.

Records of the Discussions following the presentations in each Section are included.

The international aspects of both reports and discussions and the wide range of subjects covered lend these volumes special interest. They are attractively printed and well illustrated. Radiobiologists, radiochemists, geneticists, and practicing radiologists will find in them a wealth of material.

TECHNIC DU RADIODIAGNOSTIC. By J. GARCIA-CALDÉRON AND G. LEDOUX-LEBARD. A volume of 1,148 pages, with 746 figures. Published by Masson & Cie, 120, Boulevard Saint-Germain, Paris-6°. Second enlarged edition, 1956. Price 7,000 fr., paper; 7,800 fr., cloth.

The first edition of this extensive treatise on the technic of diagnostic roentgenology appeared in 1943. Subsequent rapid advances in this field made a second edition appear to be necessary. The preparation of the second edition was interrupted by the death of the senior author.

The use of newer contrast media, the widened application of angiocardiography, new methods of examination of the biliary passages, splenoportography, gas insufflation of body cavities, and other innovations have led to expansion of the chapters devoted to special examinations. To offset this, the earlier chapters on the production and properties of x-rays, matters covered so thoroughly in numerous physical texts, have been abbreviated.

The text as a whole is subdivided into nine sections, each of which contains several chapters. The first section is devoted to a general discussion of equipment, general principles and methods, contrast agents, darkroom procedure, and protection. Succeeding sections take up the diagnostic procedures used in examining various organ systems, such as the skeleton, nervous system, circulatory system, etc. The final section concerns foreign body localization and emergency procedures, and contains special tables, a bibliography, and the indispensable index

In each section the apparatus and methods used in various examinations are described. There are no reproductions of roentgenograms, but diagrammatic sketches show how each projection with a given technic results in the production of certain shadows. Thus, to obtain the full value of the text, it becomes necessary to view actual radiographic studies in one's own practice in the light of these diagrams and the descriptions which accompany them.

The book is well bound, and the illustrations are clear. It should serve as a valuable reference for diagnostic radiologic technics.

ACTION DES RADIATIONS IONISANTES SUR L'ORGANISME. By A. LACASSAGNE, Professeur honoraire au Collége de France, Directeur honoraire de l'Institut du radium (sections biologique et thérapeutique), and G. GRICOUROFF, Chef du Service d'Histopathologie de la Fondation Curie (Institut du radium del' Université de Paris). A monograph of 198 pages, with 17 figures. Published by Masson & Cie, 120, Boulevard Saint-Germain, Paris-6°. Second edition, completely revised, 1956. Price 1,500 fr.

This monograph deals with the action of ionizing radiations upon the tissues of man and experimental animals. First, there is a chapter devoted to the methods by which ionizing radiations affect tissue in general. This is followed by chapters devoted to the effects—especially the histologic effects—upon the skin, mucous membranes, and various organ systems. A separate chapter is devoted to systemic reactions and the effects of total-body irradiation. The concluding chapter deals with the action of irradiation on pathologic tissues.

Each chapter gives a good review of the authors' experience and that of others, and each is supplemented by an extensive bibliography, making the work a valuable reference source.

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ROENTGEN DIAGNOSIS

THE HEAD AND NECK

Traumatic Intracerebral Hematoma. Review of 16 Surgically Treated Cases. Robert L. McLaurin and Bert H. McBride. Ann. Surg. **143:** 294–305, March 1956. (College of Medicine, University of Cincinnati, Cincinnati, Ohio)

Sixteen patients who survived surgical removal of an intracerebral hematoma were studied to emphasize the importance of the recognition of this treatable condition. All the hematomas followed sudden acceleration or deceleration injuries without depressed fractures. The locations were as follows: temporal lobe, 12 cases; frontal lobe, 3; parietal lobe, 1. The size ranged from 10 to 75 c.c.

With a single exception, loss of consciousness was associated with the initial injury, but the duration of unconsciousness was of little value as an indication of the presence of intracerebral bleeding. Surgical exploration was most frequently prompted by a change in the level of consciousness and development of hemiparesis. Neither pupillary changes nor jacksonian convulsions were of localizing value. Prolonged elevation of cerebrospinal fluid pressure was presumptive evidence of hematoma.

Intracerebral hematoma was suspected preoperatively only once in this series. Bilateral temporal and parieto-occipital burr holes were made in all cases, and in 7 subdural hematomas were found (2 bilateral). When unilateral, these clots were invariably on the same side as the intracerebral hematoma. The temporal hematomas were readily visible at the surface of the lobe and occasionally communicated with the subdural hematoma. Ventriculography or cerebral arteriography was unnecessary in these patients. The frontal lobe hematomas were not accompanied by meningeal bleeding and were located only by ventriculography. Roentgenographic findings were similar to those for any space-occupying lesion.

Ventriculography is recommended if, on exploration, (1) no surface hematoma is found, (2) the hematoma is insufficient to account for the clinical picture, or (3) following removal of the subdural blood, no surface hematoma is visualized and the brain herniates through the dural opening.

Ten roentgenograms; 2 photomicrographs.

RICHARD E. BUENGER, M.D.
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The Surgical Treatment of Arteriovenous Malformations of the Brain. Robert A. Hayne, Ludwig G. Kempe, and William Coxe. J. Neurosurg. **13:** 259–270, May 1956. (R. A. H., 414 Equitable Bldg., Des Moines, Iowa)

The authors present a series of 9 cases seen in the Walter Reed Army Hospital, studied pre- and postoperatively by carotid arteriography. Following demonstration of the extent and location of the arteriovenous malformation, surgical attack was planned. If the lesion was found to lie in the cerebral cortex or in some other accessible area, then it was completely excised and the "feeder" vessels clipped. Frequently an associated intracerebral hematoma was found in and around the vascular malformation. When the clot had been removed, the vessels of the malformation were more likely to be accessible and in some instances could be completely excised. Six of the 9 cases were so treated. In the remaining 3 cases the lesion was surgically inaccessible so that therapy had to be limited to clipping of the "feeder" arteries and drainage veins. Good results followed this procedure. All of the 9 patients did reasonably well or were cured. In all but 1 case one or more postoperative carotid angiograms were obtained to verify obliteration or removal of the vascular lesion.

It is concluded that early carotid arteriographic studies are indicated in patients with suspected arteriovenous malformations, even if bleeding from the lesion has recently occurred. It appears that better results follow early diagnosis and prompt surgical treatment.

Twenty roentgenograms.

JAMES W. BARBER, M.D.
Cheyenne, Wyo.

Basilar Impression. A. Tänzer. Radiol. clin. **25:** 135–152, May 1956. (In German) (Röntgeninstitut und Strahlenklinik der Städtischen Krankenanstalten, Beurhausstrasse 40, Dortmund, Germany)

The author presents in summary the radiologic diagnostic problems incident to basilar impression and reports 6 cases, including 1 of the secondary type. The primary variety is congenital and the bone structure is normal. The secondary variety is characterized by osteoporotic processes or disturbances in ossification, such as rickets, senile atrophy, Paget's disease, and cleidocranial dysostosis.

While the basal angle of the skull (from nasion to tuberculum sellae to the anterior edge of the foramen magnum) may be widened in basilar impression, it can also be altered in other diseases, as hydrocephalus. Furthermore, small degrees of basilar impression may exist with a normal basal angle, as when the paramedian condylar portions of the occipital bone are elevated.

The diagnosis of basilar impression is based upon the relation of the apex of the dens to certain established lines. Chamberlain's line runs from the posterior end of the hard palate to the posterior edge of the foramen magnum. Normally the apex of the dens lies below this line; in basilar impression it is above. Laminagraphy is necessary to identify the posterior edge of of the foramen magnum. Two additional lines of diagnostic significance are obtainable from the sagittal laminagram. The line connecting the apices of the mastoid tips normally passes through the atlantooccipital joint, and the apex of the dens should be 1 or 2 mm. above this. A more satisfactory line is that connecting both digastric fossae at the medial aspect of the base of the mastoid tip. This line lies about 1 cm. above the bimastoid line and is in direct relation with the floor of the posterior fossa. The sagittal laminagram also permits study of the floor of the posterior fossa. Normally, this should be more or less horizontal. An upward medial direction signifies basilar impression.

All the diagnostic lines are liable to error if the occipital condyles are hypoplastic and if the atlas is underdeveloped or assimilated. The apex of the dens in these cases is higher than normal. The diagnosis of basilar impression should be based on the entire

radiologic picture, rather than upon a single observation.

Thirteen roentgenograms; 10 drawings.

CHRISTIAN V. CIMMINO, M.D.
Fredericksburg, Va.

Cherubism—Familial Fibrous Dysplasia of the Jaws. Gy. Frigyesi. Fortschr. a. d. Geb. d. Röntgenstrahlen **84:** 613–617, May 1956. (In German) (Mária u. 5, Budapest VIII, Hungary)

Cherubism is a localized bone disease of the upper and lower jaw which shows definite familial and sometimes hereditary tendencies. It is never observed in infancy but usually develops at the age of three, with a few cyst-like lesions in the jaw, progressing as the child grows. Later, the entire upper and lower jaw present a foamy, bubble-like appearance on the x-ray film, and the cortical bone becomes thin and irregular. The cheeks are pushed out, producing a chubby appearance. A white streak of sclera can usually be seen above the lowered lower lid, imparting an impression of "the eyes being raised to heaven." From this aspect the name cherubism is derived. As the disease advances, the features change and the appearance may become quite grotesque.

Histologically the changes are similar to those of fibrous dysplasia. There is much fibrous tissue rich in cells, with some giant cells of the osteoclast type. Clinically the disease differs from fibrous dysplasia by the absence of involvement outside the jaw. Differentiation from von Recklinghausen's disease is easily made by the absence of changes in the serum calcium and serum phosphorus.

The author reports the case of an eighteen-year-old girl with typical x-ray findings. He believes that the disease represents a variant of the common type of fibrous dysplasia.

Three roentgenograms; 1 photomicrograph; 2 photographs.

WILLIAM A. MARSHALL, M.D.
Chicago, Ill.

Roentgen Demonstration of the Movements of the Ciliated Epithelium of the Trachea: Experiments on Isolated Tracheas of Slaughtered Animals. H. Birzle. Fortschr. a. d. Geb. d. Röntgenstrahlen **84:** 566–570, May 1956. (In German) (Röntgeninstitut der Chirurgischen Universitätsklinik, Freiburg i. Br., Germany)

The movements of the ciliated epithelium of the trachea may be studied microscopically, but the activity in only a very small section can be thus explored. Roentgenologically the broad coördinated movements over the entire trachea are observed.

The author suspended tracheas of freshly slaughtered sheep or calves in a moist chamber and introduced lead dust (small particles of lead) into the bases. The upward movement of the particles was then checked by serial roentgenograms. The following observations were made:

The movement of the particles occurs either in straight or in spiral pathways and is definitely coordinated for about six to eight hours. It then becomes uncoördinated and after twenty-four hours ceases. The speed is about 0.5 to 1.0 cm. per minute but may vary. Some sections of the epithelium stop movement occasionally, to resume it a little later. Apparently the epithelium becomes tired and requires a rest. Lowering the temperature to 0 to 2° C. stopped all movement, but on warming the epithelium again, to 25° C., normal movements were restored. At 30 to 35° C. the movements were accelerated, but at 45° C. all movement ceased. Spraying the mucous membrane with fluids of pH 2 to 9 was without effect.

Slight rubbing with the finger or a soft bronchial catheter did not affect the epithelium, but rubbing with moderate pressure or with a hard catheter stopped all movements. This is of great importance in view of the fact that tracheal instrumentation is so common a procedure, particularly since we know that ciliated epithelium, once destroyed, is seldom regenerated, being replaced by squamous epithelium.

Cocain, Pantocaine, and nicotine solutions reduce the movements considerably. Absolute alcohol produces irreversible cessation of all motion. Ether and chloroform temporarily slow down the activity.

X-ray irradiation for a single dose of 10,000 r did not stop the ciliated movements, but it must be kept in mind that radiation effects are not instantaneous and that *in vivo* the tolerance dose is probably the same as for other mucous membranes.

Two illustrations.

WILLIAM A. MARSHALL, M.D.
Chicago, Ill.

Granuloma of the Neck Following Thorotrast Angiography. Laurence F. Levy. Brit. J. Surg. **43:** 638–641, May 1956. (Department of Neurology and Neurosurgery, McGill University, Montreal, Quebec)

The author reports 2 cases of granuloma of the neck following Thorotrast angiography and reviews the literature. In most cases there is a history of intracarotid injection, followed by the development of a mass which slowly increases in size. Most of these lesions appear within a few months of the injection but a latent period as long as twenty-one years has been reported (Struppler: Deutsche med. Wchnschr. **77:** 311, 1952). In cases developing late, the original injection may be forgotten and an initial diagnosis of malignant growth may be made in virtue of the hard, infiltrating mass that is palpated.

The diagnosis may be established by visualization of Thorotrast in the soft tissues near the tumor, as well as by demonstration of radioactivity in the biopsied mass. External counting with a Geiger-Müller counter may be negative because of the filtering effect of the skin.

The author quotes various sources as to the treatment of these granulomas. None have been found to undergo malignant change and, because of the diffuse fibrous reaction which makes resection difficult, most authors recommend that no treatment be undertaken unless there is encroachment upon some vital structure.

Five roentgenograms.

JOHN P. FOTOPOULOS, M.D.
Hartford, Conn.

THE CHEST

Changes in the Endothoracic Organs Due to Positioning of the Patient. H. Hackenthal and W. Rübe. Fortschr. a. d. Geb. d. Röntgenstrahlen **84:** 556–561, May 1956. (In German) (H. H., Institut R. Koch, Föhrerstr. 2, Berlin N 65, Germany)

In their studies of patients with asthma, the authors observed some striking changes in the appearance of endothoracic organs in films taken in right and left decubitus positions, with the x-ray beam directed in a

postero-anterior, *i.e.*, horizontal, direction. Here they present a study of differences in normal patients in these positions.

The Diaphragm: On the side on which the patient is lying, the diaphragm is higher and its curvature is greater than normal. On the opposite side it is flattened and lower. The degree of elevation varies to a great extent from patient to patient, for no apparent reason.

The Mediastinum and Heart: The mediastinum is displaced toward the side on which the patient is lying. The heart follows the mediastinum, but the degree of displacement of the heart toward the right is much less than toward the left, possibly because of the presence of the rigid liver on the right side.

The Lung Markings: On the side on which the diaphragm is low the lung markings are diminished, sometimes to such an extent that none can be seen. On the opposite side (on which the patient is lying) their number is increased, so that the appearance may suggest a pneumonic process, and occasionally there are ill defined spots, resembling a mixed tuberculosis. This appearance immediately disappears if the position of the patient is reversed, even though he may have been lying on one side for many hours (as in sleep). The authors believe that these alterations in the pulmonary markings are due to circulatory changes, mainly through venous congestion.

The movements of the diaphragm cause certain changes in the adjacent organs of the abdomen. This is of significance in the clinical examination of the patient. If, for instance, a slight splenic enlargement is to be demonstrated, the downward movement of the left leaf of the diaphragm in the right decubitus position pushes the spleen downward and it becomes easier for the examining physician to palpate its border below the costal margin. The same holds true for examination of the liver with the patient on the left side.

Five roentgenograms.

WILLIAM A. MARSHALL, M.D.
Chicago, Ill.

Congenital Intralobar Sequestration with Anomalous Artery from the Aorta. Vidar Jensen and Aage Wolff. Acta radiol. **45:** 357–364, May 1956. (Roentgen Department, Namdal County Hospital, Namsos, Norway)

The authors report a case of sequestration of a portion of the lung and review the embryology and roentgen aspects. The patient, at two years of age, had a history of repeated illness with cough and fever. Radiographic examination suggested possible intralobar sequestration in the right lower lung. Surgical lobectomy verified the diagnosis. An aberrant artery originating from the lower thoracic aorta was found to ramify in the posterior half of the right lower lobe. The affected area apparently had no connection with the normal bronchial tree and had undergone cystic degeneration.

As in the case under discussion, x-rays usually disclose homogeneous opacity of a portion of a lower lobe, more often the left, and usually in the posterior basal segment. If there is communication of the involved lung with the bronchial tree, air-fluid levels may be seen within cystic cavities. Oil instilled for bronchography almost always fails to enter the sequestered part. A barium meal study to rule out hiatus hernia is indicated.

While the embryologic basis for an intralobar sequestrum is an anomalous development of the vascularization of the pulmonary anlage, this is not invariably followed by sequestration. Obvious transitional forms of pulmonary affections with a similar congenital vascular background also occur.

Eleven roentgenograms; 1 photograph.

DON E. MATTHIESEN, M.D.
Phoenix, Ariz.

A Study of Tuberculosis Cavities by Contrast Media and Other Methods. Oren A. Beatty. J. Kentucky State M. A. **54:** 424–431, May 1956. (Hazelwood Sanatorium, Louisville 9, Ky.)

The study of tuberculous cavities reported here is based upon 35 cases in which iodized oil was instilled. All the patients had careful preliminary chest examination, including conventional filming and laminagraphy, for localization of the cavities to be opacified. The point on the skin nearest the cavity was prepared as for thoracentesis. A number 19 needle connected with a manometer and pneumothorax apparatus was introduced into the cavity. After studies of intracavitary pressure were made, 2 to 10 c.c. of iodized oil was injected. The patient was then manipulated to spread the contrast material over the wall of the cavity and suitable films were obtained.

Twenty-nine cavities showed free bronchial connections and normal atmospheric intracavitary pressure. Only 4 of the cavities were completely blocked and another 2 were partially blocked. Some form of retraction or contraction of the surrounding lung tissue was apparent in all cases, usually in a superoposterior direction. Associated bronchiectasis was shown in 19 of the 35 cases but was seen only in association with cavities having free bronchial communication. Three of the 4 patients with blocked cavities had sinuses in the intra- or extrapleural space.

Auscultation directly through the needle leading into the cavity was done in a number of cases and the results are reported in some detail.

The author believes older, chronic cavities may be studied with contrast material with safety, but that recent ones with acute surrounding disease should not be traumatized in this manner. Patients so studied should be under antibiotic therapy.

Six roentgenograms; 3 tables.

JAMES W. BARBER, M.D.
Cheyenne, Wyo.

A Correlated Bronchographic and Histopathologic Study of Bronchial Disease in 216 Tuberculous Patients. Raymond F. Corpe and Eugene C. Hwa. Am. Rev. Tuberc. **73:** 681–688, May 1956. (Battey State Hospital, Rome, Ga.)

Bronchograms were obtained on 216 patients with pulmonary tuberculosis. The examination was done following bronchoscopy, and the iodized oil was injected through a catheter placed in the trachea at the time of the latter procedure. In 84 patients in the group pulmonary resections were done. In 55 of these, histopathologic examination showed bronchiectasis; a roentgen diagnosis of bronchiectasis was made in 42. In 5 patients bronchiectasis was not found in the pathologic specimen following its diagnosis on the bronchograms. Twenty-one of the 55 cases of bronchiectasis were tuberculous. The highest incidence of bronchiectasis was found in patients with areas of pneumonic and cavitary tuberculosis.

Postbronchographic spread of disease was found in 3 patients and mild reactions were noted in 26 patients. Oil retention within the parenchyma occurred in nearly 60 per cent of the series, but on only 4 occasions did retention of the oil interfere with the ability to follow the course of the disease radiographically.

A roentgenographic diagnosis of bronchiectasis was made in 46 patients who did not have surgical excisions. Of these, 11 per cent had difficulty with respect to their tuberculosis during the follow-up period, which averaged nineteen months per patient.

The authors feel that the principal role of bronchography in tuberculosis is to aid in determination of the extent of surgical resection rather than as an indication for surgery in asymptomatic patients.

JOHN H. JUHL, M.D.
University of Wisconsin

The Tuberculous Coin Lesion—A Roentgenological Symptom. (Observations in Children and Adolescents). H.-D. Renovanz. Fortschr. a. d. Geb. d. Röntgenstrahlen **84:** 536–550, May 1956. (In German) (Kinderheilstätte, Aprath, Rhineland.)

The author collected 143 examples of tuberculous coin lesions from the Children's Hospital in Aprath (Rhineland) representing 1.04 per cent of all admissions. Such lesions are fairly equally distributed over both sides, but occur much more often in the upper lobes than in the lower. Shortly after the war, as a result of poor economic conditions, tuberculosis in Germany was mainly of an exudative character, and coin lesions were not frequently seen. After 1948, with an improved economy, localized tuberculosis became more frequent and more coin lesions were observed. Most of them developed on the basis of an early infiltrate or a conglomerate infiltrate. Other modes of origin (as development following a primary focus, hematogenous dissemination, confluent growth, appositional growth, peripheral nodes, cavitation) are of only minor importance.

In the differential diagnosis the following pathological processes are to be kept in mind: primary and secondary malignant neoplasms, benign neoplasms, cysts, round foci due to parasites, gumma, and encapsulated pleuritic exudates.

Most of the coin lesions are of benign nature (about 85 per cent) and the author believes that the treatment generally should be expectant and conservative. Resection should be reserved for the larger lesions, for the true tuberculoma characterized by caseation, and those cases with liquefaction undergoing a rapid increase in size.

The tuberculous coin lesion may remain stationary, it may regress and disappear, or it may grow. It may become calcified or it may liquefy and turn into a cavity. In view of this variable course, it is difficult to give an accurate prognosis. According to the literature, 85 per cent of the cases show a favorable prognosis. The outlook becomes much more serious if liquefaction occurs, particularly eccentric liquefaction. Hemorrhage is also an unfavorable complication.

In conclusion, the author points out that the tuberculous coin lesion is but a local manifestation of a generalized systemic disease, which is another point in favor of conservative therapy.

Twenty-two roentgenograms; 3 graphs.

WILLIAM A. MARSHALL, M.D.
Chicago, Ill.

The Differential Diagnosis between Aluminum Lung and Boeck's Sarcoid. A Correction of the Article by K. H. Ehrecke. F. Leicher. Fortschr. a. d. Geb. d. Röntgenstrahlen **84:** 571–574, May 1956. (In German) (Pathologisches Institut des Kreiskrankenhauses, Ludwigsburg, Germany)

In 1951, Ehrecke reported a case of "aluminum lung with characteristic x-ray findings" (Fortschr. a. d. Geb. d. Röntgenstrahlen **74:** 408, 1951. Abst. in Radiology **58**: 761, 1952). The patient died in June 1955, with severe cardiac and pulmonary insufficiency. At autopsy, a disseminated Boeck's sarcoid was found, with no evidence of aluminum lung.

The author, in a critical discussion of this case, concludes that, generally speaking, there are no roentgen findings characteristic of aluminum lung. The patient had given a history of having worked for two years in air badly polluted by aluminum bronze dust, caused by the spraying of a steel structure. Radiologically, numerous soft, poorly outlined foci of infiltration with many small nodules were apparent, closely resembling tuberculosis, although tubercle bacilli were never found. The medicolegal experts rejected the possibility of aluminum lung, maintaining that the particles of the commercially available aluminum bronze powder were much too large (50 to 70 microns) to enter the alveoli and that the particles were covered with lacquer, making a specific chemical reaction between the tissues and the aluminum ions seem impossible.

In aluminum lung, a hyaline degeneration with fibrosis of the alveolar structure takes place after initial phagocytosis of the aluminum dust. Later, a diffuse scarring results, with very few cells. Granulomatous changes and lymph node involvement, which are characteristic of Boeck's sarcoid, are entirely absent. The structural analysis of the lung residue, done in this case by the State Institute for Pneumoconiosis Investigation, showed no metallic aluminum.

In the opinion of the author, aluminum lung could be caused only by the inhalation of the finest fat-free aluminum particles (such as aluminum oxide obtained from bauxite) but never by the large particles that are used for spraying aluminum bronze paint.

Two photomicrographs.

WILLIAM A. MARSHALL, M.D.
Chicago, Ill.

Factors Influencing the Radiological Attack Rate of Progressive Massive Fibrosis. A. L. Cochrane and W. E. Miall, with the assistance of W. G. Clarke, T. Francis Jarman, G. Jonathan, and F. Moore. Brit. M. J. **1:** 1193–1199, May 26, 1956. (Llandough Hospital, near Cardiff, Wales)

This report presents some of the early observations in a planned epidemiologic study to test the hypothesis that progressive massive pulmonary fibrosis is caused by exogenous tuberculous infection of lungs which already show definite radiologic signs of simple pneumoconiosis. Two similar Welsh coal-mining communities are being studied. In one of these all possible efforts to decrease the incidence of tuberculous infection are being made; in the other no such program has been instituted. Comparative radiographic examinations of the chests of miners in the two areas are to be made over a period of ten years, at two- to three-year intervals.

The proposed experiment is now three years along and offers no conclusive results, though it appears reasonable to conclude that at least a certain proportion of

cases of progressive massive fibrosis are tuberculous in origin. The importance of underlying silicosis and non-specific infection is not assessable from this study.

A detailed report of previously published information is given (see, for example, Cochrane, Cox, and Jarman: Brit. M. J. **2:** 843, 1952. Abst. in Radiology **61:** 284, 1953).

Three graphs; 10 tables.

JAMES W. BARBER, M.D.
Cheyenne, Wyo.

The Radiologic Picture of Intrathoracic Tumors of the Sympathetic Nervous System. Leonardo Papagni. Radiol. med. (Milan) **42:** 417–433, May 1956. (In Italian) (Università di Milano, Milan, Italy)

The author reports 3 cases of intrathoracic tumors of the sympathetic nervous system, diagnosed histologically and with the aid of roentgen studies as sympathicoblastoma, ganglioneuroma, and pheochromocytoma, respectively.

A review of the literature disclosed ganglioneuroma to be the most common of these tumors, pheochromocytoma being found only exceptionally, and sympathicoblastoma rarely. This last should be suspected in young patients presenting a large calcified mass in the posterior mediastinum, associated with costovertebral erosion, systemic reaction, and eventually metastases.

Ganglioneuromas are also found more commonly in the younger age group but affect adults as well. These growths are of smaller size, rarely display calcification, and neither metastasize nor produce a systemic reaction.

Intrathoracic pheochromocytomas are radiologically similar to ganglioneuromas, but differ in respect to a predilection for the middle age group and their manifestations of hyperadrenalism.

Nine roentgenograms.

CHRISTIAN V. CIMMINO, M.D.
Fredericksburg, Va.

Roentgenographic Findings in Respiratory Problems of Infants. S. B. Feinberg. Minnesota Med. **39:** 285–289, May 1956. (737 E. 22nd St., Minneapolis 4, Minn.)

This article is a general survey of respiratory problems in infants and their roentgen manifestations. Special mention is made of hyaline membrane disease, which the author has discussed at greater length elsewhere (Radiology **68:** 185, 1957).

Twelve roentgenograms.

THE CARDIOVASCULAR SYSTEM

The Position of Radiology in Cardiovascular Diagnosis. Fred Jenner Hodges. Minnesota Med. **39:** 276–280, May 1956. (University Hospital, Ann Arbor, Mich.)

In this paper, which is the Carman Memorial Lecture presented before the Minnesota State Medical Association, the author reviews the position of radiology in cardiovascular diagnosis. He concludes: "The present position of radiology in cardiovascular diagnosis is one of major importance and each month that position is broadened and strengthened. In this field close co-operation with the specialties of cardiology and surgery is mandatory if the full benefits of angiography are to be realized. The haphazard employment of the new and complex methods is not to be recommended and the most glittering radiographic images are of little value until they have been thoroughly and expertly analyzed. The required apparatus is costly and highly specialized, but the great value of the diagnostic results to be expected justifies the capital investment and the detachment of able radiologists from other endeavors to devote themselves to this type of work and the further advance of knowledge. The future of cardiovascular radiology appears to be brilliant and assured."

Fourteen roentgenograms.

Cardiac Septal Defects. I. Ventricular Septal Defect. Analysis of One Hundred Cases Studied During Life. II. Atrial Septal Defect. Analysis of One Hundred Cases Studied During Life. Daniel F. Downing and Harry Goldberg. Dis. of Chest **29:** 475–491, 492–507, May 1956. (Hahnemann Medical College, Philadelphia, Penna.)

The authors summarize their observations in a table (in the second of their papers) comparing the findings in 100 cases of atrial and 100 cases of septal defects.

	Atrial Septal Defect	Ventricular Septal Defect
Age range	2 wk.-61 yr.	3 mo.-52 yr.
Number under 15 yr.	27	76
Number under 5 yr.	13	39
Sex		
Male	28	50
Female	72	50
Diagnosis of congenital heart disease		
Made under 10 yr.	66	100
Made after 15 yr.	32	0
No symptoms	5	11
Fatigue	87	72
Shortness of breath	90	70
Cardiac failure	43	22
Chest pain	28	13
Cough	13	12
Paroxysms of rapid heart action	36	8
Hemoptysis	8	6
Syncope	18	6
Failure during pregnancy	2 in 38	0 in 8
Subacute bacterial endocarditis	3	0
Cerebral vascular accident	4	2
Pneumonia	26	33
Physical examination:		
Cyanosis	13	29
Thoracic asymmetry	25	52
Thrill	25	65
Cardiac enlargement	38	46
Accentuated P2	86	68
Systolic murmur	92	98
Diastolic murmur	28	18
No murmur	4	1
Electrocardiogram:		
RV hypertrophy	53 of 91	54 of 91
Right bundle branch block	20	3
RVH plus RBBB	5	0

X-Ray		
Heart enlarged 2 plus or over	64 of 92(68%)	50 of 98(51%)
Pulmonary vascular markings 2 plus or over	64	64
Main pulmonary artery enlarged 2 plus or over	66	56 of 96
Right and left branches 3 plus or over	26	2
Rt. ventricle enlarged 2 plus or more (rt. ant. oblique view)	53	45
Catheterization:		
Right-to-left shunt	24	34
Av. Right-to-left shunt	0.7 l/min.	1.2 l/min.
Av. Left-to-right shunt	5.5 l/min.	2.3 l/min.
Pulmonary hypertension equals systemic	65 8	72 48

Ventricular Septal Defects: The average patient with an interventricular septal defect was found to have one or more symptoms, *viz.*, fatigue, shortness of breath, cyanosis, cardiac failure, cardiac pain, chronic cough, paroxysmal tachycardia, hemoptysis, syncope and profuse perspiration, fatigue and shortness of breath being the most common. On physical examination, cardiac murmurs could be heard, varying in character and location. The electrocardiogram was not characteristic. It may be normal or show right heart enlargement; in one case there was left heart enlargement.

The roentgenographic findings, while not characteristic, include increased prominence of the vascular markings (in lateral two-thirds of the lungs), dilatation of the main pulmonary artery, cardiac enlargement with rounding of the left border, and prominence of the right ventricle (observed in the right anterior oblique projection). There may be asymmetry of the chest, with the left side larger than the right. On fluoroscopy, increased pulsations of the main pulmonary arteries may be observed.

A premortem diagnosis depends upon cardiac catheterization, sometimes in combination with angiocardiography. If the average oxygen content of the right ventricular samples is one volume per cent greater than of the right atrial samples, a left-to-right shunt at the ventricular level is present.

If a catheter can be passed from the right ventricle into the pulmonary artery and also into the aorta, and if the systolic pressure in the three areas is of the same order of magnitude, a ventricular septal defect is present, even if no evidences of a shunt are obtained. In such cases angiocardiography may reveal the simultaneous filling of the right ventricle, pulmonary artery, and aorta.

If a rise in oxygen content is demonstrated in the pulmonary artery and not in the right ventricle, and the electrocardiogram shows right ventricular hypertrophy, and the pulmonic pressure is lower than the systemic, then a ventricular septal defect exists. If the pulmonic and systolic pressures are equal, under these same circumstances, then the patient may have a ventricular septal defect, an aortic septal defect, or a patent ductus arteriosus. Differentiation can be made by thoracic aortography.

Although a ventricular septal defect has been thought to be of little significance, the authors' observations lead them to the conclusion that it is actually of serious import. The majority of patients have symptoms; cardiac failure occurs relatively early in life in a large number; roentgen and electrocardiographic abnormalities are the rule. Pulmonary hypertension is a frequent feature. It is believed that the large pulmonary flow results in functional contraction of the small pulmonary vessels and that this results in increased resistance to flow and heightened pulmonary pressure. Anatomic changes develop to increase resistance further. The direction of flow through the defect may thus change and a constant right-to left shunt ensue. This is the natural history of those patients who are classified as having the Eisenmenger complex, a term which the authors feel should be abandoned.

Nine roentgenograms illustrating variations in the postero-anterior roentgenogram in the presence of a ventricular septal defect are included.

Atrial Septal Defects: In atrial septal defect, the most striking roentgen finding is enlargement of the right and left branches of the pulmonary artery. Eight roentgenograms are reproduced to show the variations in shape and size of the cardiac silhouette. On a law of averages, congenital heart disease with large pulmonary artery branches will prove in the majority of cases to be due to an atrial septal defect.

The authors discuss the cardiac catheterization findings and the differences in the physiologic effects as compared to ventricular septal defects.

Patients with atrial defects are divided into five classes so far as the desirability of surgical closure is concerned. The magnitude and direction of shunt through the defect and the height of pulmonary pressure are the basic considerations.

Both of these papers are well written and well worth reading.

HENRY K. TAYLOR, M.D.
New York, N. Y.

Portable Serial Roentgenkymography in Acute Myocardial Infarction. J. J. Sampson, L. R. Felton, A. A. Goetz, R. Solomon, and B. Axelrad. Circulation **13:** 729–736, May 1956. (Mount Zion Hospital, San Francisco, Calif.)

Portable roentgenkymograms were made on 31 patients with acute infarctions daily or every other day for four or five days. In 27 patients additional films were obtained every three to seven days until death or discharge. It was hoped thus to ascertain if the procedure could give significant diagnostic or prognostic information. Delayed, diminished, or reversed pulsations were looked for in systole and retraction or lack of motion in diastole.

In 24 of the cases (77 per cent) some abnormality of the left cardiac border was found. Systolic reversal occurred in 52 per cent. It was seen in all 4 fatal cases in the series and in all showing signs of shock. It occurred early and then disappeared in 6 patients, all of whom recovered. Patients with a history of previous infarction were more likely to show reversal.

In 2 patients, spreading of the area of impaired contraction was detected before any other evidence was available. In one of these, electrocardiographic changes two days later indicated extension of the in-

farct; in the other, ventricular rupture occurred the following day.

Seven illustrations.

ZAC F. ENDRESS, M.D.
Pontiac, Mich.

Mitral-Valve Disease. A Radiologic Approach to a Physiologic Diagnosis. James B. Dealy, Jr. New England J. Med. **254:** 825–829, May 3, 1956. (Peter Bent Brigham Hospital, Boston, Mass.)

Correction of mitral stenosis by surgical attack is now a practical reality. As a result, greatly heightened significance has been placed on the accurate identification of this entity. In particular, in cases where mitral stenosis and insufficiency coexist, it has become important to determine which is the physiologically predominant lesion.

In an attempt to evolve roentgen criteria for this differential diagnosis the roentgenograms of patients on whom operative and catheterization data had been accumulated were reviewed as unknowns. Forty-three such cases form the basis of this report. Five consistently helpful factors were delineated. These are size of the main pulmonary artery, size of the left atrium, contour of the left atrium, ventricular dominance, and size of the aorta. The main pulmonary artery is more prominent in mitral stenosis. The left atrium of mitral incompetence is larger than that of mitral stenosis. More important, in mitral stenosis the contour of the left atrium as it projects posteriorly forms a discrete bulge, whereas the contour in insufficiency is that of a continuous sweeping curve to the diaphragmatic level. Right ventricular dominance is seen in pure mitral stenosis, while with increasing degrees of insufficiency there is more equal enlargement of the ventricles, expressed as lack of dominance of either one. The aorta tends to be hypoplastic with either a marked degree of mitral stenosis or incompetence; it is more normal in the intermediary range.

Other signs were found to be of occasional but not consistent helpfulness. These included heart size, appearance of the pulmonary vasculature, level of the cardiac apex, expansile pulsation of the left atrium, and valvular calcification.

On the basis of these roentgen criteria the proper physiologic classification can be predicted in about 90 per cent of cases.

Four roentgenograms; 1 diagram; 1 graph; 3 tables.

RICHARD G. LESTER, M.D.
University of Minnesota

Late Follow-Up Study of Radiologic Changes After Mitral Valvuloplasty. John E. Gary. New England J. Med. **254:** 831–835, May 3, 1956. (Harvard Medical School, Boston, Mass.)

A radiologic survey of 55 patients who had undergone mitral valvuloplasty at least one year earlier was undertaken by the author. The films were compared with those obtained preoperatively. The patients were also evaluated clinically.

Clinical improvement was felt to have occurred in all except 2 of the cases. In 30 this is graded +++, but in only 4 were there striking roentgenologic changes. An additional 19 patients showed moderate or slight improvement roentgenologically. In 17 there was an actual increase in heart size during the postoperative period; 11 of this group were felt clinically to be strikingly or moderately improved.

Although most of the patients showed a definite improvement in their clinical status, 44 being restored to a normal or near normal life, most showed no decrease in heart size and in some, as stated above, the heart became larger than it had been before operation.

Six roentgenograms; 1 photograph; 3 tables.

RICHARD G. LESTER, M.D.
University of Minnesota

Mitral Stenosis Associated with Anomalous Pulmonary Venous Drainage into a Left Superior Vena Cava. M. M. Zion. Brit. M. J. **1:** 1020–1021, May 5, 1956.

The author reports what he believes to be the first case of mitral stenosis and anomalous pulmonary venous drainage occurring in combination. Such an association increases both the pressure and the flow to the right heart, producing added strain.

The patient gave a history of rheumatic fever at twenty, an uneventful pregnancy at twenty-two, and onset of failure symptoms at thirty-eight. On admission, at forty-two, she was severely dyspneic and disabled. A preoperative chest film showed a large heart with a prominent superior mediastinum (very similar to the findings of total anomalous pulmonary venous drainage) and prominent pulmonary arteries At valvulotomy, done as an emergency procedure before any extensive studies, the left superior pulmonary vein was found to drain into a large, somewhat tortuous left superior vena cava, which joined the left innominate vein and was thus presumed to enter the right atrium *via* a right superior vena cava. The left inferior pulmonary vein entered the left atrium normally. The drainage of the right pulmonary veins was not visualized. The pulmonary artery was enormous. Tight mitral stenosis was present, with a mobile valve, which was not calcified. Convalescence was complicated but eventually there was marked clinical improvement, although no change was seen in the roentgenogram or electrocardiogram.

Postoperative studies revealed tricuspid incompetence, which was thought to contribute to the enlargement of the superior vena caval shadow.

One roentgenogram; 1 table.

ZAC F. ENDRESS, M.D.
Pontiac, Mich.

Cardiovascular Changes in Dystrophia Mesodermalis Congenita Marfan. P. Amundsen and I. Holter. Acta radiol. **45:** 365–370, May 1956. (Roentgen Department, Ullevål Sykehus, Oslo, Norway)

Dystrophia mesodermalis congenita, or Marfan's syndrome, is a hereditary condition in which there is a defective evolution or dystrophy of the mesoderm, especially the connective tissue and skeletal muscle. In addition, the media of the aorta and pulmonary arteries is affected, with degeneration often leading to rupture and formation of dissecting aneurysms. Defects are often found in the auricular septum of the heart as well.

A case with cardiovascular changes is reported. Roentgen examination showed the left auricle and ventricle to be markedly enlarged, while the right heart and aorta appeared normal. Progressive heart failure led to death at the age of twenty-one, and at autopsy an aneurysm was found involving the intrapericardial portion of the aorta.

The author points out that in many cases of Marfan's syndrome the cardiac condition so dominates the clini-

cal picture that the real diagnosis may be missed. A high index of suspicion is advised whenever left auricular and ventricular enlargement is encountered radiographically without aortic or right heart enlargement.

Four roentgenograms; 4 photographs and photomicrographs; 3 drawings.

DON E. MATTHIESEN, M.D.
Phoenix, Ariz.

Congenital Vascular Lesions Imitating the Patent Ductus. Carl Davis, Jr., Egbert H. Fell, B. M. Gasul, and Robert Dillon Arch. Surg. **72:** 838–849, May 1956. (C. D., Jr., 122 S. Michigan Blvd., Chicago 3, Ill.)

The authors list five cardiovascular lesions which may imitate a patent ductus arteriosus: arteriovenous fistula (pulmonary, subclavian, anomalous coronary circulation, internal mammary, intercostal); aortic septal defect; aneurysm of the sinus of Valsalva with rupture into the right ventricle or atrium; aneurysm of the aorta with rupture into the pulmonary artery; interventricular septal defect. Catheterization studies, angiocardiography, and retrograde aortography are most helpful in differentiation.

Four illustrative cases are reported. In the first case a congenital aortic-pulmonary fistula was found and successfully closed. The second case was quite unusual since a patent ductus was found and closed but a murmur and high pulmonary artery pressure persisted without explanation. Retrograde aortography was recommended but the parents refused. The third patient had an enlarged left coronary artery which terminated in the right ventricle after giving off its normal branches. Ligature and division of this vessel proximal to the ventricle corrected the shunt, which was probably not too important dynamically, since the heart shadow was not enlarged. The fourth case was one of a ruptured Valsalva sinus aneurysm communicating with the right atrium, found at autopsy when the patient died suddenly following an exploratory thoracotomy.

[It is interesting that at least 3 of these cases might have been diagnosed by retrograde aortography.—Z. F. E.]

Eleven roentgenograms; 2 drawings; 3 photographs; 5 tables.

ZAC F. ENDRESS, M.D.
Pontiac, Mich.

Buckling of the Carotid Artery Demonstrated by Angiocardiography. Walter Lentino, Dominick J. Principato, and Maxwell H. Poppel. Ann. Int. Med. **44:** 1003–1007, May 1956. (New York University, College of Medicine, New York, N. Y.)

The demonstration by angiocardiography of buckling of the right common carotid artery has not previously been reported. This article documents a case in which the patient presented a painful, pulsatile mass at the root of the right neck and the differential diagnosis from aneurysm could not be clinically established. Opacification of the vessel by contrast medium provided indisputable proof of common carotid buckling, and an exploratory operation was avoided.

Buckling of the innominate artery has received intensive angiographic study. Though superficially similar, buckling of the carotid produces an entirely different clinical picture. In the case of innominate buckling, a rounded density is noted in the right paratracheal region, and the differential diagnosis from tumor, aneurysm, infiltration or enlarged nodes must be made. In buckling of the carotid, the patient presents with a *normal chest roentgenogram*, complaining of a *pulsatile mass* in the right lower neck. The problem is to determine whether this is an extravascular mass transmitting pulsation or a vascular abnormality, such as aneurysm or kinking.

In the authors' patient, a 72-year-old Puerto Rican female, with a pulsatile mass at the root of the right neck, angiocardiography was performed in the left oblique position following rapid injection of 70 per cent Urokon into the right antecubital vein. The film at seven and a half seconds showed a clear-cut outline of the aortic arch and its major branches. The innominate artery was rigid and straight, bifurcating at a high level into the right subclavian and right carotid arteries. The subclavian took its origin from the medial wall of the innominate and circled around posterior to it, to emerge laterally. The carotid continued into the neck, making a sharp, crooked, reverse-S turn in the neck. The left subclavian and left carotid arteries also showed a moderate degree of tortuosity.

This case presents features of both clinical and radiologic interest. *First*, it demonstrates the fallacy of certain widely held clinical signs. Expansile pulsations are regarded by some clinicians as pathognomonic of aneurysm when seen or felt. At systole, the right carotid will fill with blood and tend to straighten out, thereby producing a lateral motion or thrust which simulates expansile pulsation. *Second*, the occurrence in an elderly, hypertensive, arteriosclerotic female is almost, in itself, diagnostic. *Third*, the origin of the kinked carotid is of interest. Hypertension produces unfolding and dilatation of the aorta, and arteriosclerosis, which usually coexists, produces concomitant lengthening. The aortic arch thereby becomes elevated, and tortuosity of the innominate, and secondarily of the right carotid and right subclavian, results.

One roentgenogram; 2 drawings.

STEPHEN N. TAGER, M.D.
Evansville, Ind.

Dilatation of the Pulmonary Artery in Pulmonary Stenosis. F. S. P. van Buchem. Circulation **13:** 719–724, May 1956. (The Department of Medicine, University of Groningen, Netherlands)

Twenty patients with pulmonary stenosis and 6 with idiopathic dilatation of the pulmonary artery were studied by both catheterization and angiocardiography. The diameter of the pulmonary artery was measured on the angiocardiograms and an attempt was made to correlate it with the gradient of pressure across the pulmonary valve as found by catheterization. It is pointed out that the appearance of the pulmonary artery on plain films or even at fluoroscopy may be rather deceiving and that angiocardiography affords the only way to obtain comparable measurements. Severe stenosis was found in some cases without dilatation and widely varying degrees of dilatation were seen in patients with the same pressures.

The author believes that his study supports the theory of Laubry (Arch. mal. coeur **36:** 62, 1943) that two separate anomalies are concerned: the valvular lesion and an abnormality in structure of the pulmonary artery. He concedes that eddy currents may play a part but, if there is no defect in the artery, there will be no dilatation.

Nine roentgenograms; 3 figures; 1 table.

ZAC F. ENDRESS, M.D.
Pontiac, Mich.

Simple Angiographic Method for the Study of the Greater Circulation. "Enlarged" Angiocardiopneumography. P. Viallet et al. J. de radiol. et d'électrol. **37:** 285–292, May-June, 1956. (In French)

In a series of three brief papers, Viallet and his associates describe the technic of "enlarged" angiography and its application to the study of the thoracocervico-cephalic, the thoraco-abdomino-pelvic, and the peripheral circulation.

This method of "enlarged" angiography comprises twelve to thirty-six serial roentgenograms of the entire trunk, exposed in nine to thirty seconds after rapid (one and one-half seconds) intravenous injection of a 70 per cent organic iodinated compound, (1 to 1.1 c.c. per kilogram of body weight), "washed down" with an identical amount of saline. The procedure is said to be "more physiological" than peripheral injection, which often causes arterial spasm and other changes. The papers contain no mention of the radiation hazard, if any, which may result from the use or abuse of this type of examination.

Twelve roentgenograms. E. R. N. GRIGG, M.D.
Cook County Hospital, Chicago

Temporary Arrest of the Contrast Medium in Angiocardiography. Alejandro Celis, Raúl Cicero, Hermilo Del Castillo, and Enrique Arce G. Acta radiol. **45:** 341–351, May 1956. (Department of Chest Diseases, Hospital General, Mexico, D. F.)

Expiratory effort against the closed glottis increases intrathoracic pressure enormously. Valsalva stated that such pressure temporarily arrests the intrathoracic movement of blood, and the present study would seem to confirm it.

During angiocardiographic examinations on 58 patients with normal circulatory systems, contrast medium was injected before and during performance of the Valsalva experiment. Films made at these times revealed a considerable influence upon intrathoracic blood flow.

The caliber of the superior vena cava is narrowed by the maneuver. Occasionally neck veins and other tributaries can be partially outlined. The right atrium is reduced in size and the tricuspid valve sharply delineated by a clear-cut border. If the catheter tip lies in the right ventricle, that chamber will be seen to be diminished in size. If the pulmonary artery is opacified, it will be found to increase in volume during the Valsalva experiment, evidently due to compression of pulmonary capillaries by increased intra-alveolar and intrathoracic pressures. If a contrast medium is injected *via* catheter into the inferior vena cava, an arrest of upward movement of the medium will be observed. This has the effect of reducing the amount of dilution of the medium. As a result, there tends to be better opacity and visualization of the structures under examination.

The authors include a review of the literature.

Seventeen roentgenograms.

DON E. MATTHIESEN, M.D.
Phoenix, Ariz.

Vascular Responses to Intra-Arterial Diodrast and Urokon During Arteriography. Robert S. Shaw. Surgery **39:** 385–388, March 1956. (Department of Surgery, Massachusetts General Hospital, Boston 14, Mass.)

Acute arterial insufficiency and gangrene complicating arteriography with organic iodine compounds has been reported, and its possible occurrence is a source of concern to anyone carrying out this procedure. Whether it results from thrombosis due to the trauma of the arterial puncture or from some direct effect of the injected material is unknown. During the two years previous to the present report, 2 instances of severe, prolonged arteriospasm following femoral arteriography were encountered at the author's hospital; during this time well over 100 femoral arteriograms were performed without any record of this phenomenon. In both cases the degree of ischemia was alarming, with accompanying motor and sensory defects, but there was recovery of the extremity to admission status after several hours. Gross evidence of ischemia appeared immediately after injection of the contrast medium, not after the arterial puncture. These cases were unique in that unusually high concentrations of medium were found in the artery. In one instance 70 per cent Diodrast was employed instead of the usual 35 per cent, and in the other arteriography was performed below an iliac artery obstruction, where there was essentially no dilution of the medium by blood. Since these cases suggested a direct vasospastic effect of the intra-arterial Diodrast, the circulation in extremities undergoing arteriography with Diodrast or Urokon was studied by means of toe plethysmography.

Three patterns of response were noted in toe pulsation following arteriography: (1) Most common was an immediate decrease in oscillation, pulses disappearing or nearly so; this was followed in one to six minutes by an increase in oscillations above the original level. This response was seen in 10 of 15 patients. (2) Three of 15 patients showed this striking decrease in oscillations, followed in three to thirteen minutes by an increase in oscillations to, but not beyond, the previous level. (3) Two patients showed an abrupt increase in oscillations without evidence of vasoconstriction.

There was a rough correlation between the intensity and duration of the initial vasoconstriction and the severity of the patient's ischemic disease. The patient with the most severe ischemia by clinical estimate did not regain oscillation for thirteen minutes after injection of Diodrast. During this period, the limb appeared quite cadaveric. The contralateral limb in most instances showed evidence of slight transient vasoconstriction immediately after injection, followed by increase in pulsations to a degree slightly above the base-line value. This contralateral vasoconstriction was minimal or absent when arteriography was unaccompanied by pain and did not appear in sympathectomized limbs.

There was no significant difference in the effects of Diodrast and Urokon in this series.

Caution is recommended in the performance of arteriography in the presence of ischemia, lest the resulting vasospasm lead to thrombosis.

Two graphs.

A Review of the Complications of Translumbar Aortography. John G. McAfee and James K. V. Willson. Am. J. Roentgenol. **75:** 956–970, May 1956. (J. G. McA., The Johns Hopkins Hospital, Baltimore 5, Md.)

The authors have reviewed the English and available foreign literature on translumbar aortography and report the complications found therein, plus those met

with in a series of 150 cases at Johns Hopkins Hospital.

The most important complications are renal damage from local reaction to contrast media, bleeding from the puncture site, intestinal injury from direct injection of the superior mesenteric artery, and anesthetic complications. Of less common occurrence are perforation of a viscus, injection of other branches of the aorta, air embolism, peripheral vasospasm, cerebral complications, spinal cord paralysis, effects on the uterus, and pneumothorax.

Renal damage is probably the most serious hazard and is believed to be due to the direct effect of the medium on the renal structures. The incidence and degree of injury are believed to be due to the concentration and quantity of the medium which enters the renal arteries. One case in which a right renal nephrectomy was required is reported here.

Bleeding from the aortic puncture site is not uncommon but is usually asymptomatic. One fatality from this occurred in the authors' series and this case is reported in considerable detail.

The major complications are discussed with reference to symptomatology and physical, roentgen-ray, surgical and postmortem findings. The minor complications are also individually considered but at less length.

Attention is called to factors which may increase the incidence of complications. Useful preventive and remedial measures are suggested.

Seven roentgenograms; 1 photomicrograph; 2 photographs.

H. C. JONES, M.D.
Grand Rapids, Mich.

A Method for Coronary Arteriography. Louis M. Levy, Donald W. Hannon, Joseph L. Sprafka, and Ivan D. Baronofsky. Ann. Surg. **143:** 412–415, March 1956. (Ancker Hospital, St. Paul, Minn.)

A single roentgenogram of the coronary circulation filled with contrast material was obtained in animals with injection, by way of a cardiac catheter, of 4 or 5 c.c. of Urokon 70 per cent into the aorta about 1 cm. above the aortic valve. The catheter was inserted via the left carotid artery. A synchronizing switch was attached to the injection syringe and was connected by means of a relay system to the roentgen-ray system.

Over 100 examinations have been performed, with good results in 95 per cent.

Two roentgenograms; 3 photographs; 1 diagram.

RICHARD E. BUENGER, M.D.
Chicago, Ill.

Successful Resections for Bilateral Pulmonary Arteriovenous Fistulas. Harold A. Lyons and Edgar P. Mannix, Jr. New England J. Med. **254:** 969–974, May 24, 1956. (Kings County Hospital, Brooklyn, N. Y.)

A thorough roentgenologic evaluation of the chest will almost always establish the diagnosis of pulmonary arteriovenous fistula. The plain film may show pulmonary opacities, but lesions at the bases and behind the cardiac shadow are often hidden. Oblique and lateral views may be necessary. Fluoroscopy aids in determining the vascular nature of the densities by showing their pulsatile character and vascular connection with the hilus. The Valsalva maneuver will decrease and the Müller procedure will increase the size of the lesion. Tomography helps to localize the fistula and may delineate the afferent and efferent vessels, but may fail to make the distinction between vascular and avascular lesions. Angiography is the procedure that definitely establishes the diagnosis. It is strongly advocated in all suspected cases, since it conclusively demonstrates the vascular nature of the pulmonary densities, it may uncover venous fistulas that would otherwise go undetected, and it provides accurate localization of the lesion.

The authors present a single case of bilateral fistulas, the third to be reported with successful resection from each lung field.

Clinically cyanosis dominates the picture. It may, however, be absent in the case of a small shunt or may disappear after hemorrhage only to reappear after a transfusion. Digital clubbing may be the first sign of lung fistula and along with dyspnea generally parallels the cyanosis. Polycythemia may be present only to disappear following severe hemoptysis, epistaxis, or gastrointestinal hemorrhage. About one-half the patients have superficial hemangiomas or telangiectases common to Rendu-Osler-Weber disease, indicating the need for careful search of accessible mucocutaneous surfaces for these stigmata in cases of suspected lung fistulas. In the absence of associated abnormality, the heart is enlarged in 20 per cent of the cases. Thoracic pain may occur as a presenting symptom. A bruit is heard over the fistula in half the cases. Inspiration increases its intensity and expiration may obliterate it.

The most interesting laboratory finding is the lowered arterial carbon dioxide tension. This was 35.6 volumes per cent before and 45.3 volumes per cent after operation in the case reported. No changes in the electrocardiogram attributable to the fistulas have been described.

Seven roentgenograms.

SAUL SCHEFF, M.D.
Boston, Mass.

The Roentgenographic Demonstration of an Arteriovenous Fistula of Renal Vessels. Anthony P. Garritano, George T. Wohl, Charles K. Kirby, and Anthony L. Pietroluongo. Am. J. Roentgenol. **75:** 905–911, May 1956. (G. T. W., VA Hospital, Philadelphia 4, Penna.)

The authors report a case of arteriovenous fistula of the renal vessels, the seventh example in the literature. The diagnosis was suspected clinically on the basis of a typical intra-abdominal murmur, and preoperative roentgen demonstration was possible through the use of translumbar aortography.

A twenty-two-year-old man had a history of two traumatic episodes in the past which could have been responsible for fistula formation, although a congenital aneurysm of the renal artery with erosion into the vein cannot be excluded. When first seen by the authors, the patient had cardiac enlargement, a loud precordial systolic murmur, blood pressure 180/60, and a loud continuous machinery murmur in the left upper quadrant of the abdomen. An intravenous pyelogram was normal except for a moderate lateral deviation of the proximal third of the left ureter just distal to the ureteropelvic junction. On translumbar aortography a large vascular structure was opacified, showing sacculations similar to hydronephrotic calices in the region of the left renal vessels. The fistula was demonstrated by visualization of both the arterial and venous components. Following surgical removal of the vascular mass and kidney, the murmurs ceased and cardiac size and blood pressure became normal.

The etiology of renal arteriovenous fistula may be obscure. Trauma may play a role. Erosion into the renal vein by an aneurysm of the renal artery has also been suggested. Erosion of the renal vessels and subsequent fistula formation secondary to renal adenocarcinoma has been reported in one instance.

Complications of untreated cases include cardiac failure, hypertension, bacterial endocarditis, and rupture of the associated renal artery aneurysm.

Seven roentgenograms; 2 drawings.

J. A. GUNN, M.D.
Grand Rapids, Mich.

Radiology of Aneurysms of the Root of the Superior Mesenteric Artery. Report of Two Cases. Gastone Peruzzi and Cesare Ruffato. Radiol. med. (Milan) **42:** 480–489, May 1956. (In Italian) (Istituto di Radiologia e Fisioterapia dell'Università de Padova, Padova, Italy)

The authors report 2 cases in which the diagnosis of aneurysm of the root of the superior mesenteric artery was determined at surgery. In both instances, there was evidence of extrinsic deformity of the stomach and widening of the duodenal loop, with anterior and lateral displacement of the duodenojejunal flexure. The radiologic findings in each case were compatible with a pancreatic cyst. The latter entity is one of several which must be considered in the differential diagnosis of lesions causing extrinsic deformities of the duodenal loop and stomach.

The difficulty of diagnosing aneurysm of the root of the superior mesenteric artery on pure radiologic grounds is emphasized, although the possibility exists when the roentgen picture is considered in conjunction with clinical data. In most cases, the condition is manifested clinically by preumbilical pain, more or less acute and persistent. After a variable period of latency, a tumor may become palpable, compressing neighboring organs such as the biliary tract, the renal arteries, and much more commonly the duodenum and stomach. Expansive pulsation is difficult to assess.

Of the three mechanisms of production for these aneurysms, infection is the most common and is almost always associated with mycotic emboli, especially in the course of subacute endocarditis; syphilis and typhoid are less frequent agents. Arteriosclerosis also plays an etiologic role. Finally, the aneurysms may be produced by trauma, which usually acts upon an artery affected with arteriosclerosis or syphilis.

While the lesions may arise in any segment of the superior mesenteric artery, they tend to occur at the site of branching, where mycotic emboli are commonly arrested. The aneurysms are usually spherical but can be fusiform; while ordinarily found alone, they may in some instances be multiple. They may impinge upon the common duct, invade the intestinal wall with resultant bleeding, or rupture into the peritoneal cavity.

Ten roentgenograms.

CHRISTIAN V. CIMMINO, M.D.
Fredericksburg, Va.

THE DIGESTIVE SYSTEM

Closing Mechanism of Lower Esophagus in Man. Radiological Study of Five Hundred Unselected Patients. Maxwell H. Poppel, Walter Lentino, Costantino Zaino, and Harold Jacobson. J.A.M.A. **161:** 196–198, May 19, 1956. (H. J., Montefiore Hospital, Gun Hill Rd., New York 67, N. Y.)

The closing mechanism of the lower esophagus was studied in 500 patients. Each was given 2 heaping tablespoonfuls of thick barium paste followed immediately by 2 ounces of extra heavy liquid petrolatum, and films were then obtained in the anteroposterior and right oblique projections, in inspiration and expiration.

The authors found no evidence of a pinchcock action of the diaphragm on the esophagus. Nor was the obliquity of the esophagogastric junction a factor in closing the lower esophagus during respiration, although in one-fifth of the 500 cases there was some change in angulation during expiration. The belief that the change in obliquity is probably a pathological aid rather than a physiologic necessity for the closing is borne out by the failure to demonstrate its presence in 400 cases.

This study confirmed the work of Palmer (Radiology **60:** 825, 1953), who used silver clips to mark the epithelial line of esophagogastric junction and demonstrated that this line was capable of automatic migration.

The closing mechanism would seem to depend largely on the lower esophageal sphincter, which lies from 0.5 to 3 cm. above the level of the diaphragm. It is at this site that a pinching effect is produced in forced inspiration. This is the level that marks the lower end of the ampulla and the upper margin of the gastroesophageal vestibule and probably serves as the attachment for the upper leaf of the elastic phrenicoesophageal membrane. The vestibule extends distally to the cardiac constrictor, where the lower leaf of the phrenicoesophageal membrane is attached and where regular longitudinal folds of the esophageal mucosa end abruptly and the coarse rugae of the stomach begin.

Two figures.

SAUL SCHEFF, M.D.
Boston, Mass.

Non-Malignant Conditions Causing Dysphagia. S. N. Deboo. Indian J. Radiol. **10:** 73–89, May 1956. (Bombay, India)

The radiological aspects of usual and unusual non-malignant causes of dysphagia are discussed. In the first ten years of life, congenital anomalies are most common. These include congenital atresia of the esophagus, congenital fistula between the esophagus and trachea or a bronchus, congenital stricture, spasm of the esophagus, esophagitis and peptic ulceration, and congenital shortening of the esophagus with hernia of the fundus of the stomach. Non-malignant causes of dysphagia in the second decade of life are neglected congenital stenosis, foreign bodies (also seen in first decade), and swallowed corrosives.

In the third and fourth decades, achalasia is the most common cause of dysphagia, being seen more frequently in men than women. In the fourth and fifth decades, sideropenic dysphagia occurs and, combined with microcytic anemia, is called Plummer-Vinson syndrome. Other causes, common in the later decades, are pharyngeal diverticula, peptic ulceration of the esophagus, partial thoracic stomach, and hiatus hernia. Benign tumors are also encountered in these older patients. Other unusual conditions which may produce dysphagia include scleroderma, syphilis, cardiovascular anomalies, bulbar and pseudobulbar lesions, and myasthenia gravis.

The different radiological technics for demonstrating these various conditions are briefly described.

GRACE E. LINDSAY, M.D.
Cleveland City Hospital

Leiomyoma of the Esophagus. Joseph Schluger, Joseph Arcomano, and Orson P. Cardon. Am. J. Surg. **91**: 852–855, May 1956. (Long Island College Hospital, Brooklyn, N. Y.)

The authors add a case of leiomyoma of the esophagus to the literature, and list the distinctive radiographic features: (1) the presence of a filling defect, usually concentric in outline, sharply defined, and crescent-shaped; (2) a lumen usually of normal caliber above and below the tumor; (3) mucosal folds ironed out or spread over the smooth intraluminal mass.

Surgical removal by enucleation is most commonly done and is recommended by the authors. Occasionally, removal by excision or resection may be necessary.

Two roentgenograms; 1 photograph.

RICHARD A. ELMER, M.D.
Atlanta, Ga.

X-Ray Manifestations of Early Malignant Gastric Ulceration. G. A. S. Lloyd. Proc. Roy. Soc. Med. **49**; 274–277, May 1956. (London Hospital, London, England)

This is a retrospective evaluation of the radiological findings in 26 cases presenting as lesser curvature ulcers in which the diagnosis was not obvious on the first examination, in other words cases showing minimal changes but proved by gastrectomy to be malignant. These are part of a larger series of 213 cases of malignant gastric ulceration studied in 1949–53.

In general the malignant ulcers presented either as a small flat or plateau ulcers or as small conical ulcers closely simulating a benign ulcer. The evolution of the plateau ulcer is usually from a simple flat projection into a similar projection embedded in a shallow filling defect, becoming progressively intraluminal in position. As it progresses further, the lesion becomes essentially an ulcerated mass and the diagnosis is obvious. When this type of ulcer is small, however, it can easily be attributed to a peristaltic wave or mucosal fold.

The conical ulcer projects further from the stomach outline than the plateau type. The majority in the author's series were originally thought to be benign radiologically, and the possibility of malignancy was suggested only when the ulcer failed to respond to medical management or a filling defect developed.

In 3 cases a benign ulcer on the lesser curvature occurred in association with, but discrete from, a malignant neoplasm.

From this study it is evident that the classical x-ray criteria of malignant ulceration are of little value in identifying early lesions. Only 25 per cent could be regarded as intraluminal originally, although many more became so on later examination. If a small ulcer is extraluminal, therefore, it should not be called benign because of this. A malignant ulcer becomes intraluminal only when the process is relatively advanced, and before this time metastasis may occur. In the same way, size of the ulcer and the absence of converging mucosal folds do not help in evaluating small lesions. The shape of the ulcer crater is by far the more important consideration. With the conical ulcer the differentiation of a benign and malignant process is possible only after observation of the behavior of the lesion under medical management. The shape of the plateau niche, however, is unlike that of a benign ulcer, and should always be considered suggestive of malignancy.

Six roentgenograms.

JOHN F. WEIGEN, M.D.
Palo Alto, Calif.

Some Difficulties in the Diagnosis of Carcinoma in the Region of the Cardia. Conway Don and D. J. L. Murphy. Proc. Roy. Soc. Med. **49**: 278–283, May 1956. (University College Hospital, London, England)

Eight cases are recorded in which an apparently benign lesion was demonstrated at the esophagogastric region. In each instance, however, a carcinoma of the esophagus or stomach was present and appreciable delay occurred in establishing the correct diagnosis because the benign lesion was accepted as explaining the patient's symptoms.

In 5 cases a hiatal hernia masked the deformity due to a malignant lesion in the upper stomach or produced an esophageal stricture which was considered the result of peptic esophagitis rather than of an esophageal carcinoma. In 1 case, carcinoma of the cardia masqueraded as achalasia for a period of fifteen months in spite of five barium meals, an air insufflation, and repeated esophagoscopies with biopsy. Compression of the lower esophagus by a tortuous aorta was not differentiated from a carcinoma, which was the actual cause of the narrowing, even though the examination was performed with this specific problem in mind. The diagnosis was established by esophagoscopy.

It must be remembered that carcinoma of the cardia may be accompanied by or may simulate a benign lesion which could account for the symptoms. No patient with a possible carcinoma of the cardia can be regarded as properly investigated until esophagoscopy has been performed.

Thirteen roentgenograms.

JOHN F. WEIGEN, M.D.
Palo Alto, Calif.

The Incidence of Benign Gastric Ulcers on the Greater Curvature. Presentation of Three Cases. John H. Feist and Jesse T. Littleton. Gastroenterology **30**: 764–771, May 1956. (J. H. F., Guthrie Clinic, Sayre, Penna.)

References to 79 reported cases of proved benign gastric ulcer on the greater curvature are listed. The authors themselves found 3 such cases in a series of 87 histologically benign ulcers of all portions of the stomach. In one patient there was a 1-cm. ulcer on the mid-portion of the greater curvature proximal to an enterostomy stoma. The second patient had 2 greater curvature antral ulcers, one of which was diagnosed preoperatively. In Case III there were 2 prepyloric greater curvature ulcers, the larger 1.2 cm. in diameter, not demonstrated on preoperative examination. Two other ulcerating lesions confined to the greater curvature were found, one a carcinoma, one a benign fibroma. Thus, of 5 greater curvature ulcerations, 3 were benign.

The authors conclude that benign greater curvature gastric ulcers should no longer be considered highly unusual. The differential roentgenologic criteria of benign and malignant gastric ulcers should be applied whatever the location.

Seven roentgenograms; 1 table.

CAPT. GARTH R. DREWRY
U.S.A.F. Hospital, Tampa, Fla.

Primary Amyloidosis. Report of a Case of Gastric Involvement Only. Anthony D. Intriere and Charles H. Brown. Gastroenterology **30:** 833–838, May 1956. (C. H. B., Cleveland Clinic, 2020 E. 93rd St., Cleveland 6, Ohio)

Primary amyloidosis of the stomach is uncommon. It may cause no symptoms or may produce hemorrhage, epigastric pain, or pyloric obstruction. The variable roentgen findings include ulceration, prepyloric narrowing (due to motility changes, well defined amyloid masses, and generalized thickening of the stomach wall), and pronounced mucosal folds. No effective treatment has been reported. Surgery such as gastric resection may be too hazardous, since the tissues may bleed easily after manipulation.

The authors report a case in a 64-year-old woman who complained of epigastric pain two to three hours after meals (relieved by food and sodium bicarbonate), occasional vomiting, and a 10-pound weight loss. Severe anemia and elevated plasma gamma globulin were noted. Roentgen examination showed gastric distention and absence of peristalsis. Scirrhous carcinoma involving the entire stomach was suspected. Gastric biopsy revealed extensive amyloid deposition in the submucosal and muscular layers. No evidence was found of amyloid elsewhere. When last seen, twenty months after the first admission, the patient had lost 20 pounds, but was otherwise unchanged. No other example of primary amyloidosis confined to the stomach was found in the literature.

Two roentgenograms.

CAPT. GARTH R. DREWRY
U.S.A.F. Hospital, Tampa, Fla.

Acute Volvulus of the Stomach. H. M. Goldberg and Vernon H. Smith. Brit. J. Surg. **43:** 588–590, May 1956. (Manchester, England)

Though something over 155 cases of volvulus of the stomach have appeared in the literature, the authors believe that only about a third of these were acute surgical emergencies. They report a case with successful operative reduction.

Acute volvulus of the stomach may occur at any age. The axis of rotation lies either lengthwise along the stomach from the cardia to the pylorus or at right angles to this. A prerequisite to volvulus is an abnormal laxity of the ligaments of the stomach. This may be congenital in origin or may be the result of stretching by some lesion in the stomach or diaphragm. Diaphragmatic hernia with rupture or relaxation of the diaphragm is the commonest single factor associated with volvulus.

Once volvulus is anatomically possible, anything causing hypermotility of the stomach may act as a precipitating cause. In the authors' case this was believed to be a gastroenteritis.

Symptoms and signs include epigastric pain, often of sudden onset; constant ineffectual retching associated with deterioration of the general condition; a palpable tense mass in the left hypochondrium. Scout films of the abdomen may be diagnostic, showing two (sometimes only one) fluid levels in the left hypochondrium with no other gas shadows in the abdomen. The fluid levels represent the stomach twisted upon itself.

In acute volvulus of the stomach, both the pylorus and the esophagus are completely occluded. Gastric secretion is unable to escape, the stomach becomes distended, the distention stimulates further secretion, and eventually ischemia and strangulation supervene.

Three roentgenograms; 1 diagram.

JOHN P. FOTOPOULOS, M.D.
Hartford, Conn.

Gastric Volvulus as a Cause of Obstruction. Report of Seven Cases. Kenneth C. Sawyer, Raymond W. Hammer, and Ward C. Fenton. Arch. Surg. **72:** 764–772, May 1956. (K. C. S., 1839 High St., Denver 18, Colo.)

Gastric volvulus may be chronic and intermittent or acute. The chronic cases usually produce relatively mild symptoms, simulating gastritis, ulcer, or gallbladder disease, and only occasionally require surgical correction. Acute cases are definite emergencies because of the likelihood of strangulation and/or rupture of the stomach. They are manifested by the triad of retching without vomiting, severe "expanding" epigastric pain, and impossibility of passing a stomach tube. Most are associated with diaphragmatic hernias, relaxed gastric ligaments, and faulty peritoneal attachment of the duodenum. Ulcers, adhesions, and tumors may also cause gastric volvulus. The usual type of twist is on the longitudinal axis, placing the greater curvature upward and to the right, closing both the pyloric and cardiac orifices.

Seven cases are presented, 6 of which were acute and 1 chronic. One was associated with eventration of the diaphragm, 1 was idiopathic, 4 were caused by ordinary diaphragmatic hernias, and 1 followed a traumatic rupture of the diaphragm. The latter was the only fatal case. Five patients were operated upon with good results. Surgery consisted chiefly of correcting the twist and repair of the diaphragm, but in 1 resection and in another posterior gastroenterostomy was considered necessary to prevent recurrence.

Ten roentgenograms. ZAC F. ENDRESS, M.D.
Pontiac, Mich.

Duodenal Loop Changes in Posterior Penetration of Duodenal Ulcer. J. George Teplick. Ann. Int. Med. **44:** 958–974, May 1956. (Kensington Hospital, Philadelphia, Penna.)

Chronic posterior perforation of a duodenal ulcer, though a fairly common occurrence, is only rarely diagnosed before surgery. The author believes that careful evaluation of the duodenal loop in routine gastrointestinal roentgenograms should frequently enable the roentgenologist to suggest the possibility.

Clinically, posterior penetration of a duodenal ulcer may be suspected from the history, symptoms, and course. Generally, there is a fairly long history of ulcer symptoms, with progressive difficulty in management. Often backache becomes a prominent symptom; the ulcer pain-food rhythm may be altered. Repeated and more frequent flare-ups of ulcer symptoms are encountered.

When the roentgenogram clearly discloses a deep posterior ulcer, chronic posterior penetration is an obvious consideration. The deep posterior crater, however, usually is not seen. A posterior tract was demonstrated in only 1 of the author's patients. The bulb deformities alone offer little clue to the diagnosis. Alterations in the normal roentgen appearance of the descending duodenal loop, on the other hand, are significant. In all the cases observed there was *effacement of the normal mucosal outlines on the inner border of the descending limb*, producing a smooth, somewhat

stiff appearance. A less constant finding was coarsening of the mucosal folds of this segment of the loop. This was apparent in 6 patients. In 4, the loop was slightly displaced, usually posterolaterally, in 1 case upward. The loop changes always involved the immediate postbulbar area; sometimes the entire descending limb was altered.

Pancreatic inflammation secondary to a penetrating duodenal ulcer is apparently of the subacute or chronic type.

The need for constancy of the changes described is emphasized. The appearance of the loop on a single film means little, since peristaltic activity, together with rapidity of present day roentgen exposures, can produce an unusual picture on a single film.

Ten cases of chronic duodenal ulcer, with roentgen findings considered suggestive of posterior extension into the pancreatic bed or into the pancreas itself, are reported. Of the 9 cases undergoing surgery, penetration of the ulcer into the pancreas was found in 6; in the other 3, dense adhesions from posterior extension were found around the bulb and second portion of the duodenum. These adhesions apparently are responsible for the roentgen changes.

Twenty-four roentgenograms; 1 diagram; 1 table.

STEPHEN N. TAGER, M.D.
Evansville, Ind.

The Contribution of Radiologic Methods of Examination to the Detection of Organic Disease of the Small Intestine. Ross Golden. Indian J. Radiol. **10:** 47–72, May 1956. (U.C.L.A. Medical Center, Los Angeles, Calif.)

A statistical study of 168 cases of organic disease of the jejunum and ileum was made to determine the incidence of certain symptoms and physical characteristics as described by the pathologist. Bleeding occurred in approximately one-half of the cases of intestinal tuberculosis and neoplasms but was relatively uncommon in regional enteritis. Diarrhea was uncommon in cases of primary neoplasm but frequently occurred in the inflammatory diseases. Abdominal pain was present in a large proportion of all cases with the exception of carcinoids.

In this series the carcinomas were most frequently located in the jejunum, with all other lesions showing a preference for the ileum. Multiple lesions were found in approximately one-third of the cases—chiefly carcinoids and lymphomas.

X-ray examination showed evidence of abnormality consistent with organic disease in 121 of 133 cases examined (90 per cent). A second study of 73 neoplasms of the small intestine was made to determine the types of abnormality demonstrable radiologically and to discover why some organic lesions are not detected.

Tumors and other organic diseases affect the small intestine by narrowing the lumen, destroying the mucosa, or obliterating the mucosal folds. Less frequent effects are mechanical ileus as a result of annular constriction, intussusception, and a filling defect produced by a mass projecting into the lumen.

The small intestine is most satisfactorily studied by routine examination with a non-flocculating preparation of barium sulfate. Examination with the Miller-Abbott tube and the small intestinal enema are necessary only in selected cases.

In the present series, failure to detect neoplasms of the small intestine appeared to be the result of (1) failure of the observer to note an abnormality shown by the examination, (2) flocculation of the barium sulfate in the intestine, (3) failure to carry out a complete study.

The specific diagnosis of a demonstrable abnormality may be impossible. In the presence of abdominal pain and/or intestinal bleeding, however, an abnormality consistent with neoplastic disease is sufficient to lead to surgical intervention.

Fifteen roentgenograms; 5 photographs; 1 drawing; 6 tables.

GRACE E. LINDSAY, M.D.
Cleveland City Hospital

The Negative X-Ray Report in Cancer of the Colon. Gordon S. Ramsay. Brit. J. Surg. **43:** 576–579, May 1956. (Gordon Hospital, London, England)

The author emphasizes the fact that a negative x-ray report on a patient with cancer of the colon is likely to lead to delay in diagnosis and treatment. One hundred and fifty-one cases of carcinoma of the colon were reviewed; 75 were examined roentgenologically, and in 10 a negative report was given. The author presents these 10 cases briefly to illustrate the errors that occurred. He feels that, in spite of a negative radiographic report, an exploratory laparotomy should be done if the history and clinical findings are suggestive of carcinoma.

[From a study of the case reports, it is difficult to understand how the author can implicate the negative barium-enema study, since in several instances the delay in laparotomy occurred when obvious clinical evidence of neoplasm was present, such as visible polyps and palpable rectal masses.—J. P. F.]

Three roentgenograms; 2 tables.

JOHN P. FOTOPOULOS, M.D.
Hartford, Conn.

The Meconium Plug Syndrome. H. William Clatworthy, Jr., William H. R. Howard, and James Lloyd. Surgery **39:** 131–142, January 1956. (H. W. C., Department of Surgery, Children's Hospital, Columbus 5, Ohio)

Intestinal obstruction due to the inability of the colon to rid itself of the meconium residue of nine months of fetal life is not uncommon in the newborn infant. In such cases it is presumed that either the meconium mass or the colonic motility is so altered that the normal unplugging process is impeded and deflation of the alimentary tract is retarded. This relatively benign form of obturation may vary from a mild stasis to a complete unrelenting mechanical obstruction.

Nine unrelenting cases are reported. The average birth weight of the infants was 5 pounds, 5 ounces (about 1 pound less than normal). All showed signs of intestinal obstruction shortly after birth. Seven began to vomit on the first day of life. None passed any meconium, although 2 evacuated a very small amount of pale mucoid material. The general appearance of the infants was relatively good. In only 2 was there marked evidence of dehydration, listlessness, and lethargy ordinarily associated with intestinal obstruction. In each instance the abdomen was moderately to markedly distended and loops of tense bowel were visible and palpable through the abdominal wall, frequently arranged in the stepladder pattern characteristic of mechanical low intestinal obstruction. In a number of the infants the veins of the abdominal wall were prominent.

The roentgen findings varied with the duration of the obstruction and the site of the meconium impaction but were quite characteristic in the 7 cases in which a barium-enema examination was done prior to the relief of the obstruction. Initial plain and upright roentgenograms revealed a generalized gas pattern with more or less marked dilatation of the entire bowel. Satisfactory differentiation between large and small bowel was, as usual in this age group, impossible. Fluid levels were visible in 3 cases. Barium-enema studies showed the rectosigmoid and usually the descending colon up to the splenic flexure (in 1 instance the transverse and in another the entire colon to the cecum) to be narrow and ribbon-like. The thin barium suspension passed through this small segment without difficulty up to the point of obstruction. The area of caliber change was either long and tapering or funnel-like. The colon proximal to the obstruction was usually dilated; after initial hesitation the barium mixture flowed gradually around the meconium mass into the gas-filled bowel. In 2 cases the terminal ileum filled with barium.

Differentiation by barium enema between the meconium plug syndrome and Hirschsprung's disease may be impossible on a single examination; when the study is repeated, however, twelve or twenty-four hours later, it has been observed that in cases of meconium plug syndrome there is a decided increase in caliber of the distal, previously ribbon-like colon and there may be migration downward of the site of caliber change. Neither of these roentgen findings has been observed in true Hirschsprung's disease, in which the area of narrowing is generally (though not necessarily) confined to a relatively short rectosigmoid segment.

Although the cause of the meconium plug syndrome has not been definitely established, the authors believe that is is probably due to a deficiency of trypsin in the meconium. In 8 of the infants in the present series the meconium was examined for the presence of trypsin, and in 6 infants serial examinations were done at daily intervals. In no instance was there tryptic activity in the first meconium. Subsequently, the meconium from the same infants showed a progressive increase in tryptic activity, and in all cases stools were positive for trypsin by the time of discharge from the hospital.

In 3 infants the obstruction was relieved by digital anal dilatation, with the passage of thick and then more fluid meconium. In 2 others relief of the obstruction followed the barium-enema examination, at which time a firm mass of meconium was passed. Two patients, who did not respond to anal dilatation or repeat barium enemas, were given dilute hydrogen peroxide enemas (one part 3 per cent hydrogen peroxide to three parts normal saline); in both, the peroxide enema was followed by the passage of large amounts of thick meconium and gas. In the remaining 2 cases a clinical and radiographic diagnosis of congenital aganglionic megacolon (Hirschsprung's disease) was made and an ileostomy or colostomy was performed; biopsy of the bowel wall in both cases showed a normal complement of ganglion cells.

All of the patients have been followed for from three months to five years; all have remained essentially well. None has shown any evidence of fibrocystic disease or experienced any difficulty with constipation, obstipation, intermittent abdominal distention or colic, such as would characterize a congenital type of megacolon.

Eleven roentgenograms; 2 photographs; 1 table.

Acute Emphysematous Cholecystitis. J. Kenneth Jacobs. Am. J. Surg. **91**: 799–803, May 1956. (Vanderbilt University School of Medicine, Nashville, Tenn.)

Two new cases of acute emphysematous cholecystitis are added to a total of 34 collected by the author from the literature and tabulated here.

The diagnosis is dependent upon the film of the abdomen or right upper quadrant showing gas in the gallbladder lumen. An air-fluid level will usually be demonstrated in the erect or decubitus posture.

Four ways by which air may enter the gallbladder are mentioned, as follows: (1) infection by gas-forming organisms; (2) reflux of air from the duodenum through a relaxed sphincter of Oddi; (3) surgical realignment of the gallbladder by cholecystojejunostomy or choledochojejunostomy; (4) spontaneous cholecysto-enterostomy.

The author believes that surgical intervention is the treatment of choice.

Three roentgenograms; 1 table.

RICHARD A. ELMER, M.D.
Atlanta, Ga.

Residual Common Duct Calculi. A. O. Singleton, Jr., and James L. Coleman. Ann. Surg. **143**: 619–626, May 1956. (Medical Branch, University of Texas, Galveston, Texas)

A common duct stone remaining after exploration may be brought to the attention of the surgeon because of persistence of jaundice, pain, digestive disturbances, or other symptoms, or it may be discovered on a postoperative cholangiogram. The same symptoms, however, can be caused by injury to the duct, pancreatitis, and other conditions. An overlooked stone should be differentiated from new stone formation by an absence of symptoms for a variable period in the latter case. False positives may occur on postoperative cholangiograms but probably less frequently than on operative cholangiograms.

In the event that a postoperative cholangiogram is reported to show residual calculi, the surgeon may do nothing except clamp or remove the tube in the common duct and await developments; he may immediately re-explore for stone; he may make a non-operative attempt to get rid of the calculi. In the latter case treatment may be aimed at flushing calculi from the ducts, relaxing the sphincter of Oddi, or dissolving the stones. Fat solvents, ether or chloroform, have been found most useful, especially when an attempt at agitation is made to further fragmentation.

The present report is concerned with 159 cases seen at the John Sealy Hospital, Galveston, in which the common duct was explored at the original gallbladder operation. In 34, exploration was limited to operative cholangiography, which was invariably negative. These patients had no further difficulty. In the remaining 125 the common duct was manually explored, and stones were found in 43. No obstruction was found in 38. Twenty-eight patients had carcinoma of the pancreas or biliary ducts, and in 11 there was stricture of the common duct. In the remainder obstruction was due to miscellaneous causes. The incidence of overlooked common duct calculi in this series was 9 per cent.

Four roentgenograms; 2 photographs.

JOHN F. RIESSER, M.D.
Springfield, Ohio

Intravenous Cholecyst-Cholangiography in Emergency Abdominal Diagnosis. Robert S. Sparkman and Paul R. Ellis. Ann. Surg. **143:** 416–421, March 1956. (Baylor Hospital, Dallas, Texas)

Ten patients were examined by means of intravenous cholecysto-cholangiography as an aid in the diagnosis of acute abdominal disease. The necessity of rapid diagnosis or vomiting prevented use of the routine oral method in these cases.

Visualization of normal bile ducts and gallbladder is presumptive evidence of the absence of acute cholecystic disease. In 1 of the authors' cases, first thought to be cholecystitis, that diagnosis was discarded when both gallbladder and ducts were demonstrated. Operation disclosed mesenteric thrombosis.

Visualization of the common bile duct without visualization of the gallbladder up to two hours is evidence of cystic duct obstruction and compatible with the occurrence of acute cholecystitis. This was proved surgically in 5 out of 7 patients in this group. A sixth patient had acute pancreatitis and a normal gallbladder. The seventh patient was not operated upon. Accompanying dilatation of the common duct was seen in the patient with pancreatitis and in the 1 patient with a common duct stone.

Failure of visualization of the gallbladder and bile ducts may result from loss of hepatic function or biliary obstruction. The 2 patients in this group had mild jaundice and were found to have cholecystocholedocholithiasis with dilated ducts.

RICHARD E. BUENGER, M.D.
Chicago, Ill.

Cholangiography after Cholecystectomy. Visualization with Cholografin by Vein. Stanley B. Reich, Leland R. Felton, and Joseph Levitin. California Med. **84:** 331–333, May 1956. (S. B. R., 1600 Divisadero St., San Francisco 15, Calif.)

Intravenous cholangiography is indicated in any patient in whom inadequate information is obtained by oral study. No true contraindication is known although the presence of severe liver damage usually results in non-visualization. The authors present 6 brief case reports to illustrate some of the findings revealed by this examination: normal ducts with or without a gallbladder, dilatation of the ducts from stones or "dyskinesia," cystic duct remnants, and pancreatic duct reflux.

Six roentgenograms; 5 drawings.

ZAC F. ENDRESS, M.D.
Pontiac, Mich.

On the Visualization of the Bile Ducts in Cholegraphy. Georg Theander. Acta radiol. **45:** 352–356, May 1956. (Roentgen Department, Malmö Allmänna Sjukhus, University of Lund, Lund, Sweden)

This is a review of 415 cholegraphic examinations performed with Biligrafin (Cholografin) injected intravenously. Satisfactory outline of the bile ducts was obtained in 29 per cent of the patients. Better results were obtained with a 40 per cent solution of a lithium salt of Biligrafin than with a 20 per cent solution of the disodium salt (commercial Biligrafin): 67 per cent satisfactory visualization with the former, as against 26 per cent with the latter.

Jaundice apparently caused a significant reduction in the number of cases with good visualization. However, liver disease without jaundice had no remarkable effect. Sex and age appeared to exert no influence of consequence. The size of the dose, between 8 and 12 gm., did not affect visualization of the duct system.

Examinations carried out in the morning were more satisfactory than those performed after noon.

Four figures. DON E. MATTHIESEN, M.D.
Phoenix, Ariz.

Experiences with Diagnostic Angiocholegraphy and "Peroperative Radiomanometry" in Cholelithiasis. A. Ritter and H. Helmig. Schweiz. med. Wchnschr. **86:** (Suppl. to No. 20) 596–600, May 18, 1956. (In German) (Chirurgischen Abteilung des thurgauischen Kantonsspitals, Munsterlingen, Switzerland)

Successful surgery for cholelithiasis requires the removal of all the calculi from all the segments of the biliary tract. This task can be greatly facilitated by roentgen examination of the tract after filling with contrast material during laparotomy. Also of help are manometric tracings obtained during introduction of the opaque medium. The term "peroperative radiomanometry" indicates the performance of both procedures, *i.e.*, filling of the biliary tract through the abdominal incision, with pressure readings and roentgenography.

In this paper, routine pre-surgical intravenous cholangiography is advocated, instead of the customary oral cholecystography, because (1) it is said to give a higher incidence of visualization, (2) it allows evaluation of the bile ducts and sphincter of Oddi, (3) it acts to a certain extent as a liver function test, and (4) it saves time, since the intravenous procedure will have to be performed in the event of non-visualization by the ingestion method.

Intravenous cholangiography is unsuccessful in over 20 per cent of cases. Moreover, even when the biliary tract is visualized, it often fails to reveal the site of obstruction in what seems to be clinically a definite "retention" icterus. Under such circumstances it is advisable to add the information gained by radiomanometry; the findings thus obtained must be adequately correlated with clinical and laboratory data, in the hope of improving the results of "biliary" surgery. Seven illustrative case histories are included.

Twenty illustrations, including 14 roentgenograms.

HILDEGARDE SCHORSCH, M.D.
Cook County Hospital, Chicago

Volumetric Findings in the Emptying Test in Non-Calculous Cholecystopathies. C. Wieser. Schweiz med. Wchnschr. **86:** 483–488, May 12, 1956. (In French) (Institut universitaire de Radiologie médicale de Lausanne, Lausanne, Switzerland)

Volumetric studies, according to the technic described by the author in a previous paper (Schweiz. med. Wchnschr. **84:** 149, 1954. Abst. in Radiology **63:** 774, 1954) were performed on a group of 18 apparently healthy controls (9 of them males). Twelve other patients without clinical or laboratory evidence of cholecystopathy were investigated, as well as 87 with evidence of biliary tract dysfunction. Volumetry requires frontal and lateral views of the gallbladder, before and after fatty stimulation. The lateral view is necessary for estimation of the volume, but is highly recommended also as the best position in which to demonstrate congenital malformations; these were found in 15 per cent of all cases. Gallbladder volumes, prior to the fatty meal in the normal subject, were 50 to 123 c.c. in the male, the average being 78, and 40 to 80

c.c. in the female, with an average of 67.5, but the author believes these figures to be relatively low.

Thirty minutes after ingestion of egg yolk is the best time to check evacuation of the gallbladder, at which time it averages about 50 per cent. Earlier it may be far below this level; later (between forty-five and sixty minutes) redistention of the gallbladder occurs more often than is suspected. The preparation of the patient is important, since those who have fasted too long will show a higher tonus and evacuation will be more rapid. Low-residue diet and enemas are of value in cleansing the colon, but if the enema is given shortly before the films are taken, the tonus may be increased.

Volumetric determinations acquire more significance when correlated with radiologic signs of emptying. A small, round, hypersthenic gallbladder, well opacified, has often become permanently irritated by a mucosal lesion or by a reflex mechanism originating in a neighboring organ. The intensity and efficiency of the emptying effort may help to distinguish a simple hyperkinesia from obstruction, as long as motility has been preserved. The interpretation of stasis should be avoided when gallbladder volume (after the cholagogue) is below 40 c.c., even with good emptying.

Among the 87 patients with cholecystopathy, there were 26 with cholecystitis, 18 with functional disturbances of the digestive tract, and 17 with organic diseases of the digestive tract (gastritis, ulcer, cancer, etc.). The remainder were classified as having extradigestive diseases, including lumbago, migraine, uterine carcinoma, and postmenopausal osteoporosis. Correlation with cholecystography revealed that in a third of the patients with cholecystitis, the gallbladder was dilated and evacuated poorly, but the author found no definite roentgenologic syndrome which could be associated with the clinical diagnosis of cholecystitis.

Timing and intensity of the emptying effort were perhaps the most significant in the differentiation of functional disturbances of the gallbladder from the remainder of the group of non-calculous cholecystopathies. These functional syndromes are listed as (*a*) relative vesicular dyskinesia (subnormal evacuation rhythm with neuro-vegetative imbalance), (*b*) vesicular hyperevacuation with or without hypertonicity, (*c*) simple hypoevacuation, (*d*) hypoevacuation associated with hypotonicity and vesicular dilatation, and (*e*) insufficient vesicular evacuation, despite repeated and sometimes even strong efforts. These, of course, must not be confused with organic obstructions in the cystic duct, common duct, or Oddi's sphincter. The author suggests additional studies, with a large volume of patient material, for further clarification of this subject.

Eight roentgenograms; 2 figures.

E. R. N. GRIGG, M.D.
Cook County Hospital, Chicago

HERNIA

Acquired Hiatus Hernia. Costantino Zaino and Maxwell H. Poppel. Am. J. Digest. Dis. **1**: 215–226, May 1956. (C. Z., 309 Bedford Park Blvd., Bronx 58, N. Y.)

The authors review the problem of acquired hiatus hernia including classification, etiology, clinical considerations, complications, roentgen differential diagnosis, and treatment. Their roentgenologic classification comprises 3 main types.

1. *Sliding hiatus hernia* consists in the upward migration of the abdominal segment of the esophagus and esophagogastric junction, through the esophageal hiatus, to above the level of the diaphragm. There are 3 subtypes: (*a*) concentric or short-esophagus type; (*b*) redundant esophagus type; (*c*) sliding hiatus hernia with paraesophageal component. Three preliminary progressive stages of insufficiency precede the occurrence of the concentric or short-esophagus type: Stage A, dilated, persistent, and slowly emptying phrenic ampulla; Stage B, high phrenic ampulla, and vestibule mostly above the right crus of the diaphragm; Stage C, gastroesophageal junction at the esophageal hiatus.

2. *Paraesophageal hiatus hernia* is defined as herniation of the stomach to one side of the esophagus through the esophageal hiatus. The gastroesophageal junction is in its normal position.

3. *Mixed type.*

Acquired hiatus hernia is the most common of the diaphragmatic hernias, although usually there is an underlying congenital weakness, in the form of a wide esophageal hiatus or defective phrenoesophageal membrane. Precipitating factors include increased abdominal pressure, decreased intrathoracic pressure, obesity, esophageal spasm, and atrophic changes in tissues. The authors believe that spasm of the esophagus is the most important of these factors in younger individuals.

Roentgenologically, the following are to be considered in the differential diagnosis: epiphrenic diverticula, cardiospasm, stricture and carcinoma, esophageal varices, prolapse of gastric mucosa, and contractile ring.

Nine diagrams.

JOHN P. FOTOPOULOS, M.D.
Hartford, Conn.

THE SPLEEN

Does "Laparoscopic" Splenoportography Indicate an Advance in the Field of Medical X-ray Diagnosis? A Contribution to the Early Diagnosis of Intrahepatic Obstruction. L. Wannagat. Fortschr. a. d. Geb. d. Röntgenstrahlen **84**: 509–525, May 1956. (In German) (Kuranstalt Haus Schwaben der LVA Württ., Bad Mergentheim, Germany)

The demonstration of the portal vein system through direct percutaneous injection of water-soluble radiopaque material into the spleen has given valuable information, but has been fraught with many undesirable complications (hemorrhage, rupture of the spleen, injury to other organs, etc.). The incidence of dangerous side-effects has been reported as 29.5 per cent.

In order to minimize such complications, the author has carried out the procedure in the following manner: The needle is introduced into the spleen under laparoscopic control. The injection of the contrast material is done under direct fluoroscopic observation and a large spot-film is taken when maximum filling of the portal system has been attained. Serialograms may be obtained if desired, but in that event direct fluoroscopic control must be sacrificed. The pressure in the spleen is measured before and after the injection.

Certain precautions are necessary. Back flow of the medium through the puncture hole in the capsule may occur if the needle is not inserted deep enough or if there is an obstruction in the biliary system. A sudden resistance to the injection should not be overcome with force, since rupture of the spleen may result.

If the point of the needle lies too close to the capsule, a subcapsular injection may be produced. If the spleen is very small, the needle may pass through the spleen substance and deposit the medium beyond the spleen. Bleeding can usually be prevented by withdrawing the needle gradually after completion of the injection, allowing for the complete withdrawal a little longer than the previously determined coagulation time of the blood.

The author has obtained 204 splenoportograms in 168 patients. Normally the portal system is compared to a tree in winter. In cases of inflammatory disease (hepatitis) there is unequal filling of the vessels. Some branches are blocked. Dilatation of the lumen due to congestion, followed by contraction, is observed. There is curved distortion of other branches and few peripheral vessels are seen. As the hepatitis progresses, the changes become more obvious.

The presence of extrahepatic or intrahepatic stasis or a block can also be recognized by enlargement of the spleen, by difference in the pressure as measured before and after injection, and by reflux filling of the collateral vessels.

Twenty-three roentgenograms; 3 sketches.

WILLIAM A. MARSHALL, M.D.
Chicago, Ill.

THE MUSCULOSKELETAL SYSTEM

Multiple Epiphysial Dysplasia. Edmund Shephard. J. Bone & Joint Surg. **38-B:** 458–467, May 1956. (Orthopaedic Department, St. Bartholomew's Hospital, London, England)

Three cases of multiple epiphyseal dysplasia in three generations of one family are described. Three additional members had a history of painful hips since childhood but were not examined. Usual features of this dysplasia are irregularity in density and outline of several developing epiphyses (usually including the femoral and humeral heads), permanent deformity of the epiphyses, osteoarthritis later in life, stubby digits, and short stature. The patients described, a boy of fourteen, his mother, and grandmother, exhibited these characteristics in varying degree. In addition, small rounded lips arose from the boy's femoral condyles, with a depression between the lip and the condyle. The heads of some of the metacarpals and phalanges showed similar depressions. Vertical striation of the distal ends of the femora was also noted in the boy, a finding apparently not previously described in this dysplasia.

Twenty-one roentgenograms; 2 photographs; 1 diagram.

CAPT. GARTH R. DREWRY
U.S.A.F. Hospital, Tampa, Fla.

Multiple Myeloma. A Case Diagnosed Without X-Ray Evidence of Bone Lesions. Morris E. Freedland. California Med. **84:** 354–355, May 1956. (420 E. Carson St., Long Beach 7, Calif.)

The diagnosis of multiple myeloma in this unusual case was first made from a bone-marrow smear eighteen months after the onset of symptoms (mostly back pain). On three separate occasions during the first thirty months of the disease x-ray studies were done, but no areas of destruction could be found even after the diagnosis was established. Lytic lesions finally appeared in the ribs and vertebrae, with pathological fractures occurring in both. The patient lived two years after this, without severe discomfort until the last three months. The total time from the onset of symptoms to death was four and a half years.

ZAC F. ENDRESS, M.D.
Pontiac, Mich.

Solitary Eosinophilic Granuloma of Bone. T. Hunter. J. Bone & Joint Surg. **38-B:** 545–557, May 1956. (Oldchurch Hospital, Romford, England)

Eight cases of solitary eosinophilic granuloma of bone in patients aged fifteen months to thirty-nine years are described, involving the clavicle, humerus, rib, ilium, femur, and vertebrae. The presenting symptom was usually pain, occasionally swelling. Radiographically all lesions showed an area of bone destruction, irregular or smooth. There was subperiosteal new bone formation in 4 cases, with cortical destruction. Cortical expansion and loculation have been described but were not found in this series. Pathologic fractures are uncommon, but occurred 3 times, in a clavicle and a thoracic vertebra as a presenting finding and in a femur following biopsy.

Two patients were treated by radiation (dose unstated), the others by curettage or excision. All were relieved of pain. Follow-up of four months to five years showed no recurrence. The effect of treatment is difficult to assess, however, since resolution may occur spontaneously.

Nineteen roentgenograms; 1 photomicrograph.

CAPT. GARTH R. DREWRY
U.S.A.F. Hospital, Tampa, Fla.

Alkaptonuric Arthritis. A. J. Harrold. J. Bone & Joint Surg. **38-B:** 532–538, May 1956. (Orthopaedic Department, St. Bartholomew's Hospital, London, England)

Two cases of alkaptonuric arthritis, in a man aged fifty-three and a woman aged fifty-seven, are presented. Both had homogentisic acid in the urine, scleral pigmentation, stiffness and blueness of the pinnae of the ears, and a history of back pain beginning at about the age of forty. Radiographs of the spine demonstrated the characteristic narrowing and calcification of the intervertebral disks. The man's knees and the woman's shoulders showed narrowing of the joint space, sclerosis, and lipping.

Changes in the symphysis pubis, not emphasized in previous reports, were found in both patients. In one there were narrowing of the joint and sclerosis of the adjacent bone; in the other, tenderness over the symphysis, and erosion and sclerosis resembling osteitis pubis. Although both patients had had surgery close to the pubis, the author does not hold this responsible for the changes. He feels that ochronosis acts as a predisposing factor to osteitis pubis.

Twelve roentgenograms; 3 photographs.

CAPT. GARTH R. DREWRY
U.S.A.F. Hospital, Tampa, Fla.

Clinical and Roentgen Aspects of Fracture Cases. R. Patry and S. Gueukdjian. Schweiz. med. Wchnschr. **86:** (suppl. 20) 593–596, May 18, 1956. (In French) (R. P., 20, rue Sénebier, Geneva, Switzerland)

A fracture may exist even when the roentgenogram exposed immediately after an injury seems to be "negative." Three instances (an intertrochanteric fracture, incomplete fracture of the greater trochanter, and a fracture of the radial styloid) are presented as

examples. In such cases the fracture line becomes visible after one to two weeks because of adjacent demineralization of the bony structures, sometimes as a result of separation and displacement of the fragments, and occasionally only as an area of osteosclerosis (callus).

The authors, who are orthopedists, emphasize the need for individual evaluation of each patient and recommend protective splinting or a cast in all doubtful cases, from the point of view both of possible subsequent disability and medical liability. The legal implications of the "roentgenographically negative fracture" are discussed.

Seven roentgenograms.

WILLIAM T. MESZAROSZ, M.D.
Cook County Hospital, Chicago

Bone Changes in Leprosy. D. E. Paterson. Indian J. Radiol. **10:** 90–97, May 1956. (Christian Medical College, Vellore, India)

Over a period of four years, the bone changes in the hands and feet of 116 leprosy patients were examined radiographically and correlated with the clinical history and physical findings. As a result, three main types of bone change in leprosy are described.

(1) Specific destructive changes are attributable to a "lepra reaction," a violent tissue response to *M. leprae* either local or general. These changes may be minimal with pseudocyst formation and subsequent healing with little shortening of the phalanx. In more severe cases, a destructive process which expands the cortex may occur. In the majority of cases, the subarticular bone is involved, with collapse of the articular surface and a resulting "cupping" deformity. Concentric or eccentric subperiosteal bone erosion also occurs, with or without subluxation.

These specific bone lesions must be differentiated from those associated with sarcoidosis, tuberculosis, multiple enchondromata, xanthomatosis, mycetoma, rheumatoid arthritis and degenerative arthroses, neurosyphilis and syringomyelia and psoriasis.

(2) Non-specific erosive and destructive changes in the bones occur in neuroleprosy, varying according to the stage and site of non-specific infection. These changes include: (*a*) hazy bone destruction—osteitis, (*b*) destruction of the shaft with subperiosteal involucrum formation and an appearance typical of osteomyelitis. The healed stage shows many varieties of deformities.

(3) The third type of bone change is osteoporosis, which was observed in 23 per cent of the cases and believed to be due to disuse rather than to specific action of *M. leprae*.

Seven illustrations.

GRACE E. LINDSAY, M.D.
Cleveland City Hospital

A Roentgenographic Study of Skeletal Lesions in Sarcoidosis. George N. Stein, Harold L. Israel, and Maurice Sones. Arch. Int. Med. **97:** 532–536, May 1956. (G. N. S., Graduate Hospital of the University of Pennsylvania, Philadelphia 46, Penna.)

The authors report the results of a roentgen study of skeletal lesions in sarcoidosis. Roentgenograms of the hands and feet were obtained in 81 patients who were proved to have sarcoidosis; 14 (17.2 per cent) showed characteristic osseous changes. The authors use single or multiple round or oval radiolucencies in the epiphyses, surrounded by a zone of normal bone—the so-called "punched out" lesion—as one criterion of sarcoid involvement. A second type of bone change is that in which the cortex of the bone is thin and the medullary cavity widened, with a reticular trabecular pattern, producing a lattice-work configuration. A third type is characterized by mutilation; the lesions appear to coalesce and produce bone destruction.

Involvement of the bones is more common in the hands and feet than in other parts of the skeleton. Complete bone surveys in 10 patients having such lesions showed involvement of other bones only rarely.

Roentgenographic demonstration of the lesions in the bones of the hands and feet is corroborative for the diagnosis of sarcoidosis and should be performed in all patients in whom the disease is suspected.

Seven roentgenograms.

THEODORE E. KEATS, M.D.
University of Missouri

Bone Lesions Secondary to Cancer of the Uterus. J. Roussel, P. Schoumacher, and Mme. Pernot. J. de radiol. et d'électrol. **37:** 380–385, May–June 1956. (In French) (Centre anticancéreux de Lorraine, Lorraine, France)

Among a total of 650 patients with cancer of the uterine cervix, metastatic bone lesions were found in 7 (in 4 cases to the spine—C-3, T-3, T-11, and T-12, respectively—and in 1 case each to the knees, the right femur, and the pelvis). In 2 additional cases there was direct extension to L-2 and to L-4. All but 1 of the 9 neoplasms were of the squamous-cell type.

In a total of 40 patients with endometrial carcinoma, the growth extended by contiguity to adjacent bones in 3 (L-3, L-4, and pelvis, respectively); in a fourth case, a distant metastasis was found in the lesser trochanter.

With the exception of 1 of the cervical cancers with distant metastases and the endometrial carcinoma with bone metastases, the primary growth had received no treatment. The bone lesions were in all instances of osteolytic appearance.

Eleven roentgenograms; 2 tables.

E. R. N. GRIGG, M.D.
Cook County Hospital, Chicago

Extradural Cysts of the Spine. G. Lombardi and A. Passerini. Ann. di radiol. diag. **29:** 408–415, 1956. (In Italian) (Istituto Neurologico di Milano, Reparto di Radiologia, Milan, Italy)

According to the authors, only 35 cases of extradural cysts of the spine are reported in the literature. These cysts are usually observed in adolescents, and correct diagnosis may not be easy unless one keeps in mind the typical bony lesions, the possibility of demonstrating the cyst by myelography, and the clinical symptomatology.

The cysts are located behind the spinal cord, on the mid-line. There is a long clinical history, with symptoms strongly suggestive of progressive compression of the cord, with eventual spastic paraplegia and sensory disturbances (deep pathways). Transitory spontaneous remissions are described. There is no pain, and the spinal tap reveals total or partial block.

X-ray studies show widening of the spinal canal (involving several vertebrae) and enlargement of the intervertebral foramina, partial destruction of the pedicles, juvenile kyphosis, and myelographic evidence of block. These changes, however, may also occur with other benign space-occupying lesions (lipomas or

teratomas of spinal cord). In the case of epidural cysts no foci of calcification in the cystic wall are noted. The preoperative diagnosis is established without doubt when the contrast medium enters the cystic cavity and defines its boundaries.

The fifteen-year-old-boy studied by the authors presented other congenital anomalies (genu valgum, pes contortum), as well as an atrophy of the left lower limb, probably as a result of the cord lesion. The myelogram demonstrated two cysts in the dorsal segment of the spine (D-7 to D-9, D-11).

Five roentgenograms; 2 drawings.

R. G. OLIVETTI, M.D.
Newington, Conn.

Vertebral Osteomyelitis Following Operation on the Urinary Tract or Sigmoid. The Third Lesion of an Uncommon Syndrome. Edwin L. Lame. Am. J. Roentgenol. **75:** 938–952, May 1956. (51 N. 39th St., Philadelphia 4, Penna.)

Osteitis pubis and low-grade osteomyelitis of the hip have been reported following surgery on the urinary tract, presumably arising from an obvious or obscure infectious process occurring pre- or postoperatively. The author cites examples of vertebral osteomyelitis which he regards as the third link in the same disease process. Two of his cases followed rectosigmoid operations, while the third developed after prostatectomy.

The mechanism of spread of the infection is explained by Batson's well known work on the vertebral veins and their anastomoses. By transpubic injection of contrast material in a living patient the author has confirmed the pelvic channels and their extensive ramifications.

The organisms commonly found include the colon bacillus, *Proteus*, *Staphylococcus aureus*, and *Pseudomonas*, which are, of course, commonly found in urinary tract infections.

Clinically, back pain is the prime symptom of this condition. It is frequently not severe at the onset, becoming marked only later, when there is vertebral crush deformity. Commonly the interval between the infection or operation and the onset of pain is several weeks but this has varied from four days to several years. The majority of the vertebral lesions are in the lumbar area, with dorsal and cervical vertebrae following in that order.

In the roentgenograms, narrowing of the disk space and lytic changes of the adjoining cortices of the bodies are early findings. One or more segments may be involved. Later, crushing of vertebral bodies occurs. Relatively early in the healing stage new bone production is seen. No pathognomonic appearance exists and differentiation from neoplasm, tuberculosis, typhoid, brucellosis, and the more common pyogenic infections is at times difficult. The history, blood and urine cultures, involvement of the disk space, and the time and extent of new bone production are all helpful in the differentiation. The end-point radiologically is vertebral fusion, which is solid and often homogeneous in character, through which the disk space may be seen. Fusion usually occurs in eight months to two and a half years.

Treatment is relatively difficult. The organisms appear to be more resistant in bone than in the original location, and the antibiotics have been without any great benefit. If the organism can be isolated, sensitivity tests may be helpful in this respect. Bed rest in hyperextension has been the most valuable measure for the relief of pain and crushing of the vertebrae.

Eighteen illustrations, including 11 roentgenograms.

J. A. GUNN, M.D.
Grand Rapids, Mich.

Vertebral Metastasis in Renal Carcinoma: An Anatomic Correlation. George T. Wohl. Am. J. Roentgenol. **75:** 930–937, May 1956. (VA Hospital, Philadelphia 4, Penna.)

Renal carcinoma frequently metastasizes to the dorsolumbar spine. This is explained on a mechanical basis by the close integration of the renal venous drainage and the venous drainage of the spine by means of the vertebral plexus of veins. The connection between the renal venous drainage and the spine is particularly common on the left side.

With occlusion of the main renal vein, as by a tumor thrombus, an extensive venous collateral drainage develops, which further increases the chance for communication with the paraspinal veins.

Four case reports of metastatic spread of left renal carcinoma to the spine are included. In one of these cases contrast material was injected into the vertebral body which contained the metastatic neoplasm and reflux through the venous system into the region of the kidney tumor was well shown, thus confirming the mechanism of spread.

Six roentgenograms; 2 drawings.

J. A. GUNN, M.D.
Grand Rapids, Mich.

Hidden Anvil Fracture of the Seventh Cervical Vertebral Body. M. C. Harrison and Ian Macnab. Canad. M. A. J. **74:** 820–822, May 15, 1956. (Toronto General Hospital, Toronto, Ontario, Canada)

Some of the difficulties encountered in radiography of the lower cervical spine are emphasized by the following case report.

A twenty-eight-year-old man slipped and fell 15 feet to the ground. His chief complaint was of pain between the shoulder blades and in the mid chest anteriorly. Neurologic examination did not disclose any evidence of nerve root compression or irritation. An anteroposterior roentgenogram revealed gross asymmetry of the neurocentral facets betwen C–6 and 7. The lateral view was unsatisfactory because it showed nothing below the level of C–5. A left oblique view demonstrated a subluxation of the inferior articular facet of C–6 and a fracture of its inferior margin. The smooth outline of the intervertebral foramen was broken by step deformity of the neurocentral facets. A slightly better lateral view was obtained when manual countertraction was applied to the wrists. This disclosed an intact C–6 and suggested a chip fracture of the anterosuperior portion of C–7.

It was felt that x-ray findings warranted the diagnosis of fracture and dislocation of the cervical spine, and skull traction was applied. After reduction by increasing traction, radiography was repeated. Manual traction was applied to the skull tongs, and counter traction was exerted by pulling on the patient's wrists. A bulky rolled-up towel was placed between the scapulae, allowing the shoulder masses to drop backward in addition to being pulled downward by the wrist traction. The resulting film showed that the anterior half of C–7 had been split off in a coronal plane.

A lateral view revealed an increased interspinous space between C–6 and 7.

The neurocentral facets afford another landmark for determining the anatomy of cervical spine injuries. Asymmetry of these facets may be the only radiographic evidence of severe damage to the spine. It is imperative, therefore, to obtain a good lateral view of the lower cervical spine. This may be achieved by the method described or certain modifications thereof.

Five roentgenograms; 1 drawing.

W. T. CADMAN CHAFFIN, M.D.
Mercy Hospital, Pittsburgh

The Results of Lumbo-Sacral Fusion for Low Back Pain. E. G. Shaw and J. G. Taylor. J. Bone & Joint Surg. **38-B:** 485–497, May 1956. (Nuffield Orthopaedic Centre, Oxford, England)

Fifty-two cases of lumbar fusion including the lumbosacral joint, with posterior onlay bone grafts, were followed for at least one year. There were 17 cases of spondylolisthesis, 28 of intervertebral disk degeneration, 3 of structural anomaly, and 4 of non-specific low back pain. Successful bony fusion, determined by lateral radiographs in flexion and extension, was obtained in 60 per cent. The mortality was 3.5 per cent. Failures were attributed to too short an immobilization period (less than ten weeks), insufficient quantity of bone, and poor apposition of the graft to the bed. In a ten-year-old child treated for spondylolisthesis of the fifth lumbar vertebra there was subsequent development of spondylolysis of the third lumbar vertebra at the upper end of the graft.

Seventy-one per cent of the patients were relieved of symptoms, with the best results in the spondylolisthesis group. The operation should be done for low back pain only in the presence of a definite diagnosis and a limited extent of structural pathology. It is inadvisable to undertake lumbar-lumbosacral fusion for intervertebral disk degeneration when more than three adjacent vertebrae are involved. When an unnecessarily long graft is used, a pseudarthrosis above the level of the preoperative lesion may be the cause of persisting backache.

Nineteen roentgenograms; 7 graphs; 5 tables.

CAPT. GARTH R. DREWRY
U.S.A.F. Hospital, Tampa, Fla.

Vertebral Trephine Biopsy. Wolfgang Ackermann. Ann. Surg. **143:** 373–385, March 1956. (Francis Delafield Hospital, New York, N. Y.)

In order to determine the presence or absence of vertebral metastases a method of biopsy of the lumbar vertebrae has been perfected. The procedure, for which specially designed instruments are employed, is carried out under radiographic control. Material was obtained from 223 bones of 150 unselected patients with malignant disease. Metastases were demonstrated in 17, or 11 per cent. In a few cases bones other than the spine were biopsied and in 50 patients both iliac crest and vertebral biopsies were done.

Only 57 per cent of the vertebral metastases discovered were visualized roentgenographically (8 out of 14). All metastases that had been demonstrated roentgenographically were positive on vertebral trephine biopsy.

Thirteen roentgenograms; 3 photomicrographs; 5 drawings; 4 tables.

RICHARD E. BUENGER, M.D.
Chicago, Ill.

Congenital Rib Anomalies. Statistical Study of 10,000 Roentgenograms. R. Pionnier and A. Depraz. Radiol. clin. **25:** 170–186, May 1956. (In French) (Sanatorium Grand-Hotel, Leysin, Switzerland)

In this statistical article the authors compare their findings of congenital rib anomalies (cervical ribs, agenesis, synostosis, bifid ribs, etc.) with other series reported in the literature. Their material is analyzed according to frequency of multiple anomalies per patient, the level of the anomalies, and the particular anomalies occurring at a given level.

Congenital rib anomalies were noted in 5.72 per cent of 10,000 roentgenograms reviewed, and three-quarters of the abnormalities were seen in C–7 and D–1.

For details, the original paper must be consulted.

Ten tables; 1 diagram.

CHRISTIAN V. CIMMINO, M.D.
Fredericksburg, Va.

Cyst-Like Structures in the Proximal End of the Ulna: Anatomic and Roentgenological Appearance and Interpretation. G. Iannaccone and M. Barillà. Fortschr. a. d. Geb. d. Röntgenstrahlen **84:** 598–603, May 1956. (In German) (G. I., Via di Villa Torlonia 6, Rome, Italy)

On lateral roentgenograms of the elbow joint a small cyst-like bone defect is sometimes seen where the coronoid process of the ulna joins the olecranon, just below the trochlear notch. No satisfactory explanation of this could be found in the various textbooks on anatomy.

In a study of 2,000 lateral roentgenograms of the elbow joint, the author found 248 examples of this cyst-like defect, an incidence of 12.4 per cent. Most of the defects are small, measuring about 1.5 mm. in diameter, but they may attain a diameter of 3 mm. or slightly more. The smaller ones are mostly round, the larger ones somewhat oval. The margins are sharply defined. Sometimes there are two or three such defects. They may be bilateral and for the most part are visible only on a true lateral view. A slight variation in the angle of exposure may result in non-visualization.

The authors studied numerous dry bone specimens and found a small opening in the compact substance of the bone in the area described, having all the characteristics of a nutrient foramen. They also examined the elbows of 10 cadavers and could definitely demonstrate a vein entering the bone in this area, indicating that the small cyst-like structure is actually a nutrient foramen.

Thirteen roentgenograms; 3 photographs.

WILLIAM A. MARSHALL, M.D.
Chicago, Ill.

Contradiction of the Congenital Dysplasia-Predislocation Hypothesis of Congenital Dislocation of the Hip Through a Study of the Normal Variation in Acetabular Angles at Successive Periods in Infancy. John Caffey, Rose Ames, William A. Silverman, Charles T. Ryder, and Gary Hough. Pediatrics **17:** 632–641, May 1956. (J. C., 630 W. 168th St., New York 32, N. Y.)

Although the cause of congenital dislocation of the hip is unknown, it has been widely accepted to be the result of congenital dysplasia or predislocation occurring during intrauterine life, with conversion to partial and then full dislocation after birth. This predis-

location phase is marked by an upward tilting of the lateral portions of the "acetabular roof," thus increasing the acetabular angle as measured by the Hilgenreiner method.

According to this theory, there are clinical signs in the predislocation phase which are useful in the diagnosis. These are said to be limitation of abduction of the flexed thigh on the affected side and asymmetry of the skin folds of the thighs with deepening and increasing of the folds on the ipsilateral limb. The mainstay of the diagnosis of predislocation has been the x-ray demonstration of increased acetabular angles and it has been said that a diagnosis can be made in the light of such x-ray changes even in the absence of clinical signs.

According to the authors, the greatest fallacy of this hypothesis is to be found in the measurement of the acetabular angle by the method of Hilgenreiner. As thus measured, the angle does not represent the real ilial articulating parts, the cartilaginous roof and its labrum, but is based upon the edge of a neighboring ossification center which lies in the ilial cartilage at a considerable distance cephalad to the actual, roentgenologically undemonstrable cartilaginous roof.

Various authors have assigned upper limits of normal to the acetabular angle, above which preventive treatment should be instituted for predislocation, the traditional standard being 30°. The authors of this paper studied this angle at birth in a heterogeneous group of 627 infants; in 551 of these it was re-examined at six months, and in 527 again at twelve months. From their observations, it was obvious that 30° is a fallacious value for separating normal from enlarged acetabular angles in the newborn. If this criterion had been used one-half of the 147 newborn white female infants and approximately the same percentage of 149 Negro females would have been subjected to treatment.

At six months of age the angles showed a marked reduction in size in all groups (males, females, white, colored) compared with the neonatal values. A slight but further reduction occurred at twelve months of age. The angles in the Negro and white infants are about equal at birth, but stay larger in the former group at six and twelve months, despite the virtual non-existence of congenital hip dislocation in Negroes.

Clinical signs as determined by careful examination by two capable orthopedic surgeons independently led to the finding of asymmetrical thigh folds, extra folds, and limitation of 60° bilateral abduction in a significant percentage of infants. Leg shortening was present in 2.7 per cent. Two signs of predislocation were present in 2.0 per cent. There was little difference of the incidence of these 3 signs in the sexually and racially different groups. Strangely enough, the white female group in which congenital hip dislocation is most common showed the lowest incidence of these clinical signs.

The authors conclude from their findings that the current practice of diagnosing a predislocation phase of congenital hip dislocation from radiologically enlarged acetabular angles or the clinical signs noted, and instituting prophylactic therapy on this basis, is erroneous and should be discouraged.

Two roentgenograms; 4 tables.

SAUL SCHEFF, M.D.
Boston, Mass.

Mongolism (Mongoloid Deficiency) During Early Infancy—Some Newly Recognized Diagnostic Changes in the Pelvic Bones. John Caffey and Steven Ross. Pediatrics **17:** 642–651, May 1956. (J. C., 622 W. 168th St., New York 32, N. Y.)

Several skeletal stigmata of mongolism have been well documented, but changes in the pelvic bones of mongoloid infants have not previously been reported. Among 1,500 unselected newborn infants examined clinically and roentgenologically for determination of the acetabular angles by the method of Hilgenreiner (see preceding abstract), there were 5 with mongolism. Thirteen infants ranging in age from two to ninety days, and a fourteenth, six months of age, were similarly studied.

The acetabular angle was smaller in the mongoloid group than in the normal infants. Particularly was this true of the mongoloid males, who showed distinctly smaller angles than the females. In frontal roentgenograms of the mongoloid pelvis the iliac image was wide and low, with flaring of the wings and a low position of the anterior superior iliac spines.

In establishing a standard for comparison of the iliac bones with those of normal infants the authors used a measurement which they called the "iliac angle." This angle is formed by an oblique line extending from the lateral margin of the iliac body to the outermost portion of the iliac wing above and a horizontal line such as that drawn through the lower edges of the Y cartilages. Normally there is little change in this angle in the first year of life. The mean value, as determined in 40 infants, ranged from 55° at birth to 58° at one year, with a tendency to remain fairly constant in the same individual at different ages. In mongoloid infants the iliac angles tend to be smaller, the mean averages ranging from 45° at birth to 40° at six months.

In normal infants no correlation was found between the size of the iliac angle and the acetabular angle. In mongolism at least one of these was small. By adding the values for the two acetabular angles to the sum of the two iliac angles and dividing the total by 2, a figure called the iliac index was reached. The mean value of this index at birth in the normal infants was found to be 81 compared with an expected low figure of 62 for mongoloids. At six months the mean value was 79 for the normal and 62 for the mongoloid infants. The iliac index, while admittedly of little help in the borderline case, may prove more useful in the early diagnosis of mongolism than either the acetabular angles or the iliac angles taken separately, since the index narrows the zone of overlap between the normal and the mongoloid infant.

Three roentgenograms; 2 drawings; 3 figures; 5 tables.

SAUL SCHEFF, M.D.
Boston, Mass.

A Method of Measuring the Torsion of the Femur in Congenital Dislocation of the Hip in Children. W. Edgren and L. E. Laurent. Acta radiol. **45:** 371–376, May 1956. (Orthopaedic Hospital of the Invaliidisäätiö, Helsingfors, Finland)

It is generally agreed that there is a higher degree of antetorsion of the femur than normal in congenital dislocation of the hip. Since this may render the reduced hip unstable, with a tendency to redislocation during the course of treatment, determination of the extent of torsion is of importance. The authors review the methods which have been used and present in detail the procedure they have employed since 1947. This they call the Schultz-Edgren method.

After a contrast medium (Uriodone 35 per cent) diluted with an equal amount of saline has been injected into the hip joints, the patient is placed upon the table on his back. The hips and knees are flexed to 90°, the legs lying horizontally on a support, the height of which is adjusted to the length of the thighs. The legs are fixed with sand bags so that they are parallel; the femurs are also parallel. The central ray is directed half way between the hip joints and the symphysis pubis. A line bisecting the femoral heads is then drawn on the roentgenogram, as well as a line parallel to the lower edge of the film. The medial angle formed is the angle of antetorsion.

Femoral antetorsion was measured according to this method in 58 patients with congenital dislocation of the hip. The patients ranged from one to seven years of age, with a mean of two years. Among the 90 hips examined, a great range of antetorsion was found: 30 to 80°, with a mean of 50°. Lanz reported the normal antetorsion to be 30° at the age of one year and 20° at three to six years.

In 62 cases operative and roentgenologic measurements of antetorsion could be compared. Operative measurement gave a mean value of 40°, 10° less than the mean determined roentgenologically. The authors point out the sources of error in measurements, by both their method and the method used at operation. They conclude that the Schultz-Edgren procedure, although it does not give absolutely exact values, is clinically applicable and the figures obtained may offer indications for the correction of the antetorsion and also suggest the prognosis.

One roentgenogram; 1 photograph.

J. P. CHAMPION, M.D.
Grand Rapids, Mich.

THE GENITOURINARY SYSTEM

The Anatomy of the Intrarenal Arteries in Health and Disease. F. T. Graves. Brit J. Surg. **43:** 605–616, May 1956. (Kings College Hospital, London, England)

Plastic-cast studies of the intrarenal arteries of normal human kidneys have shown that there is a segmental arrangement of these vessels which is constant, and that between the segments there is no collateral arterial circulation. On the basis of the arterial distribution, the renal parenchyma is divided into five segments—the apical, upper, middle, lower, and posterior—each of which is supplied by its own artery. The lack of collateral circulation was confirmed by arteriograms. In contrast to the intrarenal arteries, the intrarenal veins present no segmental arrangement there being a free anastomosis of the venous channels throughout the kidney. The main venous trunks entering the hilus vary in number from one to four.

The Nature of "Aberrant" and "Accessory" Arteries: It has been the accepted view that the kidney is supplied by a single renal artery entering the hilus and that any other vessel entering the organ at one or the other pole is an additional and aberrant source of supply to that provided by the main artery. The author's study showed this not to be true but rather that many of these so-called accessory arteries are in fact normal segmental arteries arising precociously from the main stem. The ligation of a vessel on the grounds that it is an accessory artery may thus lead to necrosis of a segment or part of a segment of the kidney.

In the present series it was found that in 63 per cent of cases the artery to the lower segment has the most proximal origin of the three segmental arteries of the anterior division. It may arise from the anterior division, the main stem artery at any point between the hilus and the aorta, and not infrequently it will arise from the aorta itself.

The Segmental Arteries in Tumors and Cysts: The disturbance of the arterial anatomic pattern when displaced by cysts and tumors is described. The area occupied by the cyst is avascular, but the segmental arterial pattern is undisturbed and the cortical pattern is normal, extending to the edge of the cyst. In carcinomas the pattern is less uniform. In 3 specimens illustrated the area occupied by the tumor is vascular with corresponding distortion or absence of the segmental vessels. The presence of "pooling" was noticed in one specimen of advanced growth. The author believes that the "pooling" so often noticed is produced not by a collection of the medium in abnormal vessels in the tumor but is attributable to delayed emptying in the intrarenal venous system which results from partial obstruction of the veins caused by growth within their lumen.

The Segmental Arteries in Calculous Disease: In planning the site of resection of the kidney substance for calculous disease one must plan to remove the diseased calicine bed in which the stone has matured along with the stone. Otherwise additional stones may form or residual infection may be left. Since partial nephrectomy has been proposed for the treatment of stone, it is important to know to what extent segmental arteries may be altered in the diseased kidney.

The author found remarkably little disturbance in the distribution and arrangement of the intrarenal arteries in association with calculous disease. Even when hydronephrosis was present, with dilated calyces containing calculi, the segmental arteries were not displaced and, indeed, the calicine dilatations appeared to have grown around them. The pattern of the finer cortical vessels in the segments of the kidney showed considerable change compared with normal. They were frail and lacked the definition seen in the films of normal kidneys. This lack of solidarity was most evident in the region where the stone was present, the finer vessels being elongated and tortuous, especially when the cortex was particularly avascular.

A technic for renal arteriography at operation is described.

Seventeen roentgenograms; 9 photographs, 6 in color; 3 diagrams.

JOHN P. FOTOPOULOS, M.D.
Hartford, Conn.

Diagnosis of Intermittent Hydronephrosis: Importance of Pyelography During Episodes of Pain. Reed M. Nesbit. J. Urol. **75:** 767–771, May 1956. (University of Michigan Medical School, Ann Arbor, Mich.)

In the investigation of vague, intermittent pain in one of the upper abdominal quadrants or in the kidney region, it is important in the performance of pyelography that it be undertaken during the occurrence of the pain or that conditions which bring on the symptoms be simulated at the time of examination. It is only at this time that an intermittent hydronephrosis or a non-functioning kidney may be demonstrated. Pyelography during an attack of ureteral colic due to calculus, for example, will reveal either hydronephrosis or non-function, but on the day following the episode,

when the symptoms have vanished, the urogram will be normal. Again, a normal picture may be obtained in children with ureteral reflux on excretory pyelography, while delayed cystography will reveal enormous widening of the ureters and pelves.

The author cites 5 cases bringing out the importance of the performance of x-ray study at the time of symptoms. In 3 cases aberrant vessels caused intermittent occlusion of the ureter. In 1 the hydronephrosis appeared to be a postural effect and in another the result of excessive fluid intake.

Eleven roentgenograms. SAUL SCHEFF, M.D.
Boston, Mass.

Excretory Pyelography in Infants. Technique for Intravenous Injection. Edward B. Singleton and Gunyon H. Harrison. Am. J. Roentgenol. **75:** 896–899, May 1956. (E. B. S., 6621 Fannin St., Houston 25, Texas)

A technic for intravenous pyelography in infants, utilizing the intravenous infusion set devised by Gardner and Murphy (Am. J. Dis. Child. **80:** 303, 1950), is described, and a brief discussion of the difficulties encountered in obtaining satisfactory excretory pyelograms in infancy is given.

The injection is usually made into a vein in the scalp, hands, wrist or feet. Films are obtained after injection of the opaque material at intervals of five, ten, fifteen, and thirty minutes. A sweet carbonated drink is given as soon as the injection is begun. This serves not only to demonstrate the kidneys through the air-filled stomach, but by quieting the child greatly facilitates the taking of films.

With this technic over 200 consecutive pyelograms in infants and young children have been performed without failure to introduce the contrast material into a vein.

Two photographs. JOSEPH P. TOMSULA, M.D.
Baton Rouge, La.

Roentgenographic Behavior of the Ureter. Hunter B. Frischkorn, Jr. Am. J. Roentgenol. **75:** 877–883, May 1956. (1000 W. Franklin St., Richmond 20, Va.)

This article, supplemented by an extensive bibliography, is an excellent treatise on the ureter, considered as a separate organ with a specific function. Anatomy and physiology are described, as well as the changes which may occur with denervation, obstruction, stimulation, infection, surgery, and other conditions.

A review of this type requires reading in the original, for an adequate abstract is impossible. The following is taken from the author's own summary:

"Single film urograms may not demonstrate the true nature of ureteral activity, and multiple or serial exposures may be necessary for proper evaluation. The functioning ureter is in constant movement, and short exposures are preferred. The normally functioning ureter can be expected to empty the upper urinary tract in from seven to ten minutes when filling is by the retrograde method. This is the most accurate single criterion regarding ureteral function which can be demonstrated urographically. However, in excretory urograms, delayed function without evidence of obstruction renders this measure valueless."

JOSEPH P. TOMSULA, M.D.
Baton Rouge, La.

The Significance of Ureteral Studies in Surgery of the Colon and Rectum. H. E. Bacon and L. McCrea. Schweiz. med. Wchnschr. **86:** (suppl. 20) 532–533, May 18, 1956. (H. E. B., Medical Tower, 255 S. 17th St., Philadelphia 3, Penna.)

In this study the authors attempt to correlate preoperative retrograde urographic observations and findings at surgery for lesions of the colon and rectum in 86 patients (66 with carcinoma, 7 with diverticulitis, 6 with adenomatous polyps, 5 with chronic ulcerative colitis, 1 with lymphogranuloma venereum stricture, and 1 with radiation proctitis).

The position, course, and symmetry of the ureters were normal in 50 (58 per cent) of the total, including 2 with unilateral ureteral reduplication. Asymmetry or deviation of the ureters was reported roentgenologically in 22 (25.6 per cent), but in only 10 (11.7 per cent) was this confirmed by surgery. Emphasis is placed especially on the "medial deviation" (called "medial fixation" by Spillane, Kaiser, and Prather, who reserve the term "medial deviation" for postsurgical deformities caused by scarring and adhesions), which is considered to represent an unfavorable prognostic sign, indicative of extensive intra- and extracolonic disease. Unilateral failure to introduce the ureteral catheter, which occurred in 14 (16.3 per cent) patients, reflected poor correlation in this series; in only 2 of the cases was ureteral deflection found at operation, as a result of disease of the bowel.

The authors consider ureteropyelography a valuable adjunct for routine use in the preoperative evaluation of colonic disease.

LEON LOVE, M.D.
Cook County Hospital, Chicago

Cystourethrography. Clinical Experience with the Newer Contrast Media. Joseph J. Kaufman and Murray Russell. Am. J. Roentgenol. **75:** 884–892, May 1956. (J. J. K., 435 N. Roxbury Drive, Beverly Hills, Calif.)

The authors take exception to those statements which affirm that some oily substances may be used for cystourethrography. They go further and make a dogmatic statement that "no oily substance injected into any part of the body is without hazard." To illustrate their position further, they report a case in which death followed the use of an oily medium (Iodochloral) for urethrography. Fat emboli were found in the brain, lung, heart, and kidneys.

Urokon sodium 70 per cent mixed with a water-soluble lubricating jelly (Lubafax) and Salpix are recommended as providing a close approximation to the ideal medium for urethrography, in respect both to safety and roentgenographic quality. The authors advocate the voiding cystourethrogram, which they feel has received too little attention. Their technic is as follows: The patient is asked to retain urine for two to three hours before the examination. The Brodny clamp is used on all males. Thirty cubic centimeters of medium is slowly injected with the patient recumbent and an anteroposterior film is taken during the last phase of the injection. The patient is then positioned for the oblique projection and a film is taken just before the introduction of an additional 30 c.c. of medium is completed. The Brodny clamp is then removed and the patient is placed in the upright oblique position. He is asked to void into a disposable plastic bag attached to the penis and, as soon as the stream

has attained momentum, a third exposure is made.

Twenty-two roentgenograms; 1 photomicrograph.

JOSEPH P. TOMSULA, M.D.
Baton Rouge, La.

Urethrocystographic Classification of Prostatism. M. L. Brodny and S. A. Robins. Schweiz. med. Wchnschr. **86:** (suppl. 20) 541–543, May 18, 1956. (M. L. B., 636 Beacon St., Boston 15, Mass.)

Urethrography with an opaque medium has been used to classify prostatism on the basis of the directional enlargement of the gland and the positional displacement of the urethra. Prostatic obstruction may be caused by (1) hyperplasia, involving (*a*) the urethral prostate, (*b*) the vesical prostate (subsphincteric or transsphincteric), or (*c*) the rectal prostate, singly or in combination; (2) fibrosis; (3) fibromuscular hypertrophy; (4) calcification; (5) carcinoma; (6) infection. For technical details and anatomical correlation, reference is made to previous publications by the same authors, though the main roentgen features in the more often encountered conditions are described. The degree of diagnostic accuracy obtained, warrants the use of urethrography in determining the therapeutic approach in cases of prostatic enlargement.

Sixteen roentgenograms; 1 drawing.

JOSE B. BRIONES, M.D.
Cook County Hospital, Chicago

Position of the Patient for Roentgenologic Interpretation of Prostatogram. A. Estin Comarr. Am. J. Roentgenol. **75:** 893–895, May 1956. (VA Hospital, Long Beach 4, Calif.)

Prostatograms have been found useful during routine cystourethrography in patients with spinal cord injury. Radiopaque material within the prostatic ducts will generally be visualized over the region of the symphysis pubis or just above. The position of the patient during roentgenography, however, may be such that the prostatic area is projected at a higher level, with the result that the opacified ducts may be confused with seminal vesicles. The author reports a case in which this occurred. Performance of seminal vesiculography permitted an unequivocal differentiation.

Four roentgenograms.

JOSEPH P. TOMSULA, M.D.
Baton Rouge, La.

Serious Complications Associated with the Newer Diagnostic Methods in Urology. William Baurys. J. Urol. **75:** 846–851, May 1956. (Guthrie Clinic-Robert Packer Hospital, Sayre, Penna.)

Among the newer methods of diagnostic study in urology are retroperitoneal pneumography and aortography. Pneumography, whether by instillation of air through a needle near Petit's triangle (perirenal insufflation) or in the retrorectal space in front of the coccyx (Ruiz Rivas), is a potentially hazardous procedure. The danger of hemorrhage, following perirenal insufflation, is overcome by the retrorectal method of Ruiz Rivas but both procedures are fraught with the hazard of air embolism. The air reaches the heart chambers, giving rise to a "mill-wheel" type of murmur, and rapidly spreads to the coronary and cerebral vessels.

While it is true that pneumography yields excellent roentgenograms, actually any renal tumor demonstrable by this procedure can be recognized by more conventional and less dangerous technics. In the opinion of the author, with the possible exception of demonstrating adrenal tumors, the method is not of significant diagnostic value, and in the average clinic can be practically discarded.

The complications of aortography, though less often fatal, can also be of a serious nature. Most commonly encountered is paraplegia. In one instance at least, this was attributed to thrombosis of the anterior spinal artery following difficulty in introducing the needle into the aorta. However, needle trauma can hardly be a factor in femoral aortography, which has also been followed by paraplegia. Periaortic and superior mesenteric injection of the medium and injection directly into a renal artery are other complications. With the use of the organic iodides, danger from these sources is minimized. Aortography, like pneumography, should be used only where there is a high degree of suspicion of a lesion incapable of being shown by more conservative methods.

SAUL SCHEFF, M.D.
Boston, Mass.

MISCELLANEOUS

A Simple Approach to the Roentgen Diagnosis of Abdominal Tumors in Infants and Children. Charles M. Nice, Jr., Alexander R. Margulis, and Leo G. Rigler. Am. J. Roentgenol. **75:** 977–993, May 1956. (University Hospitals, Minneapolis 14, Minn.)

The authors present a method of roentgen diagnosis of abdominal masses in infants and children based upon careful topographical analysis, general roentgenologic characteristics, and various relatively specific signs considered in the light of statistical probability. No effort is made to present all the diagnostic signs of abdominal tumors of childhood; the purpose is rather to describe an approach to the diagnosis of these masses.

The following classification is suggested:

I. Intraperitoneal masses
   1. Masses in the regions of the liver and spleen
   2. Other intraperitoneal masses

II. Extraperitoneal masses
   1. Masses of the renal and adrenal regions
   2. Other extraperitoneal masses

Useful diagnostic information derived from the history, physical, roentgen and laboratory examinations is utilized in arriving at a diagnosis. Physical and roentgen findings in other parts of the body may be helpful. A rather comprehensive knowledge of the disease processes involving the abdominal viscera of children is shown and capably utilized. The value of intelligent use of statistical probability in reaching a diagnosis is stressed.

Special roentgen procedures, such as pneumoperitoneum, retropneumoperitoneum, and contrast injections may be needed but are rarely, if ever, necessary if the information available on the plain film is fully utilized. The value of the lateral view in routine and special examinations is emphasized, as it often furnishes vital additional information.

The correlation of diagnostic information available from easily accessible sources will increase the percentage of diagnostic accuracy.

This is a very valuable article and anyone who spends the time to acquaint himself with its contents will be richly repaid for his effort. Thirty-seven illustrative roentgenograms are reproduced.

H. C. JONES, M.D.
Grand Rapids, Mich.

Some Rare Causes of Vomiting in Infancy and Childhood. S. P. Rawson. Proc. Roy. Soc. Med. **49:** 269–274, May 1956. (Royal Hospital for Sick Children, Glasgow, C. 3, Scotland)

Five cases are reported in which radiology not only established the cause of vomiting in a young child but also revealed an unusual underlying factor. Briefly, the conditions demonstrated were as follows: (1) a coin lodged in the upper thoracic esophagus as a result of extrinsic pressure at this site by a posterior esophageal diverticulum; (2) obstruction of the distal duodenum by extrinsic pressure of a duplication cyst of the bowel; (3) malrotation of the colon, with intermittent volvulus of the mid-gut and compression of the duodenum by torsion at the mesenteric root; (4) gross hydrocephalus; (5) neuromuscular dysfunction at the pharyngoesophageal junction, with regurgitation through the nose and into the trachea.

Twelve roentgenograms. JOHN F. WEIGEN, M.D.
Palo Alto, Calif.

Radiological Manifestations of Hyperparathyroidism. J. G. Duncan. Proc. Roy. Soc. Med. **49:** 283–286, May 1956. (Royal Infirmary, Edinburgh, Scotland)

Clinically, primary hyperparathyroidism may present in several ways. Although renal and skeletal symptoms predominate, a fair proportion of patients complain mainly of abdominal symptoms, headache, and general weakness. Cases may thus be referred for x-ray examination with a fairly wide variety of provisional clinical diagnoses. The radiologist can be of considerable assistance, particularly in the presence of generalized bone disease and renal calculi.

Four cases are reported in which the roentgen examination gave the first indication leading to the diagnosis of hyperparathyroidism.

Six roentgenograms. JOHN F. WEIGEN, M.D.
Palo Alto, Calif.

Kartagener's Syndrome. A Case Report. E. Finkler. Schweiz. med. Wchnschr. **86:** 631–633, May 26, 1956 (In German) (Chest Clinic, Raanana, Israel)

The author presents 3 new cases of Kartagener's syndrome (situs inversus, bronchiectasis, and alteration in the nasal mucosa), observed during routine fluoroscopic studies in a clinic in Israel. Situs inversus has been reported from Norway to occur in 0.01 per cent of the examined population, with associated bronchiectasis in 8 to 23 per cent of the cases (0.0008 to 0.0023 per cent of the population). Of 20,000 patients examined in Israel 0.02 per cent had situs inversus. A similar report from Vietnam gave an incidence of 0.03 per cent, one from North Africa 0.02 per cent, and a summarized report from Europe 0.008 per cent.

Of the cases of situs inversus in Israel, only 4 per cent showed bronchiectasis, though bronchiectasis without situs inversus, as well as cystic lung disease, is more frequently found in that country than is reported from Europe.

Two roentgenograms. JULIUS HEYDEMANN, M.D.
Chicago, Ill.

An Unusual Case of Lindau's Disease. Cystic Disease of the Kidneys and Pancreas with Renal and Cerebellar Tumors. Frank Isaac, Irwin Schoen, and Phyllis Walker. Am. J. Roentgenol. **75:** 912–920, May 1956. (F. I., VA Hospital, Long Beach, Calif.)

Lindau's disease is a rare condition in which angiomatous cysts of the cerebellum occur in association with tumors and cysts of the abdominal organs, chiefly the pancreas and kidneys. It may be associated with angiomatosis of the retina, resulting in von Hippel-Lindau's disease.

The authors report a case with several unusual features. A hemangioblastoma was removed from the right cerebellar hemisphere approximately six years after the onset of symptoms. Surgery was followed by deep roentgen therapy and the cerebellar symptoms showed no further progress. Some two years later, however, attacks of hematuria supervened and roentgen examinations over a period of eighteen months disclosed a gradually enlarging tumor in the right upper abdomen and a smaller mass on the left. Repeated pyelographic studies suggested bilateral polycystic disease with the possibility of a neoplasm in the right kidney. In 1953, five years after the removal of the cerebellar lesion, an abdominal aortogram revealed numerous small blood vessels and capillaries replacing the normal renal vascular pattern and apparently outlining a large mass in the right kidney. A chest film showed nodular shadows throughout both lungs, obviously representing pulmonary metastases. At autopsy cysts were found in the kidneys and pancreas in addition to a primary renal tumor with metastasis to the opposite kidney, lungs, pleura, and right cerebellar hemisphere, the site of the hemangioblastoma previously removed. After considerable speculation it was concluded by the authors that the cerebellar tumor found at autopsy represented a neoplasm metastasizing to another neoplasm.

It is felt by some that all vascular lesions in the cerebellum are probably a manifestation of Lindau's disease, and it is therefore suggested that any patient with a cerebellar angiomatous lesion should be followed by excretory urography at least once a year to demonstrate the possible development of cystic changes in the kidney.

Five roentgenograms; 12 photomicrographs; 4 photographs. J. A. GUNN, M.D.
Grand Rapids, Mich.

Timed-Disintegration Capsules. An In Vivo Roentgenographic Study. Theodore M. Feinblatt and Edgar A. Ferguson, Jr. New England J. Med. **254:** 940–943, May 17, 1956. (T. M. F., 150 Woodruff Ave., Brooklyn 26, N. Y.)

An *in vivo* roentgenographic study of timed-disintegration capsules showed that, contrary to the common impression, the contents are scattered widely throughout the length of the gastrointestinal tract before the individual particles disperse or dissolve. The popular belief that the mass of the capsule contents remains in a single mass, based on an artist's conception, is shown to be erroneous.

In the present study four different kinds of Nyscaps (Nysco Timed-Disintegration Capsules), containing radiopaque barium sulfate as a substitute for the usual active medication were used. The first type was for immediate disintegration, the second for timed disintegration in about two hours, the third in about four hours, and the fourth in about six hours. Roentgenograms were taken immediately after ingestion and repeated in two, four, six, eight, and ten hours.

The roentgenographic technic demonstrated a longer disintegration time than the modified U.S.P. method: two to four hours as compared to two hours, four to

six hours as compared to four hours, and six to ten hours as compared to six hours. It is believed that roentgenography offers a more accurate picture because it is an *in vivo* method.

Seven roentgenograms; 1 table.

AUTHORS' ABSTRACT

TECHNIC

Lymphadenography. A New Method for the Visualization of Enlarged Lymph Nodes and Lymphatic Vessels. (Preliminary Report). Sven Bruun and Arnfinn Engeset. Acta radiol. **45:** 389–395, May 1956. (Roentgen Department, Rogalund Sjukehus, Stavanger, Norway)

The authors have devised a new method for the roentgenographic demonstration of lymph nodes and lymphatic channels. Iodipin has proved to be the most satisfactory contrast medium. The technic of injection is described and illustrative roentgenograms are included. The possible danger of spread of the neoplastic process is mentioned but this seems negligible.

A total of eleven injections have been done in patients suffering with various forms of lymphadenopathy, as inguinal abscess, generalized lymphosarcoma, leukemia, Hodgkin's disease, and metastatic carcinoma. The lymphatic structures were most clearly visualized in lymphosarcoma and leukemia.

As the radiopaque material remains in the nodes for some time, the method is useful for determining the value of irradiation therapy or other treatment. It opens up, also, new therapeutic possibilities in connection with injection of radioactive isotopes into parts of the lymphatic system. One of the authors has begun a systematic study of the application of the method for diagnostic and therapeutic purposes.

Eight roentgenograms. H. C. JONES, M.D.
Grand Rapids, Mich.

Improved Syringe for Angiography. B. Selverstone, R. H. P. Yuan, and C. V. Robinson. J. Neurosurg. **13:** 303–304, May 1956. (New England Center Hospital, Boston, Mass.)

The authors describe a special syringe designed for smooth, quick injection of contrast material for angiographic studies. The plunger is of tubular stainless steel with a Teflon end, which produces an air-tight ring seal where it makes contact with the all-glass barrel. Advantages of this syringe are the uniform friction factor, insuring smooth action, and the fact that blood does not adhere to the plunger, so that repeated injections may be made with one syringe. Over 100 percutaneous injections have been done without complications.

One diagram; 1 photograph.

JAMES W. BARBER, M.D.
Cheyenne, Wyo.

Pantomography of Deep Layers. A Preliminary Report. Pekka Soila. Acta radiol. **45:** 377–382, May 1956. (Central Institute of Radiation Therapy, Institute of Dentistry, University of Helsinki, Finland)

Pantomography was originally developed to depict entire curved surfaces on a single film. In this preliminary study it is applied to the examination of layers at any desired depth. The technic appears best suited to such structures as the skull, pharynx, or chest, where symmetry is an important factor.

Stereoscopic and other special technics not used in conventional tomography are practical with pantomography and tomographic blurring is diminished. The layer obtained is dependent upon the combination of the object position, its rotation, and the movement of the film. Variations of opacity and speed of motion of the structures adjacent to the cut section determine the amount of blurring present. Proper projection and kilovoltage selection are among the problems to be worked out in each instance for optimum results.

Several demonstration radiographs are included, showing good anatomic detail obtained with this technic.

Five roentgenograms; 4 drawings.

J. A. GUNN, M.D.
Grand Rapids, Mich.

The Summation Image in Diagnostic Roentgenology. Joseph Duhamel and Daniel Herpe. J. de radiol. et d'électrol. **37:** 316–329, May–June 1956. (In French) (Chaire de Clinique d'Electricité Médicale, Faculté de Médecine de Bordeaux, Bordeaux, France)

Even a strictly descriptive ("lazy") radiological report is never purely so, because nobody can really dissociate his manner of describing a feature from a tentative interpretation of it. Excluding inattention, speed (superficiality), and incompetence, one's efficiency in "picking up" abnormalities depends largely on the momentary psychological climate at the time of the reading. Certain findings may not be discovered unless anatomical and clinical correlation can be made or until progress examinations have become available. And yet, especially in retrospect, a particular finding may have faced the examiner on the first roentgenogram, as in a trick drawing which contains more than one portrait or depicted object, the "other" aspect being clearly seeen when pointed out or spontaneously discovered. In either case, the image is ambivalent, and the viewer must decide which one to choose. Against these pitfalls, one may apply experience and such automatic solutions as stereo procedures, multiple projections, and analytic studies (body-section roentgenography, etc.).

In essence, the roentgenogram is a "flat" drawing in white, black, and several shades of gray, that cannot possibly be evaluated without considering the exposure factors. In practice, this requirement is supplanted by experience, one having in mind the image of what is considered excellent technic. Actually, one may have to use different factors in the same region, so as to bring out, by differences in contrast, the area under investigation. A "beautiful" roentgenogram is not necessarily the best for diagnostic purposes, as certain features may be best, if not exclusively, demonstrated with under- or over-penetrated exposures.

It is of advantage to determine how far we can trust the roentgenogram. Because of weak installations, *i.e.*, short target-skin distances, early authors believed that what is closest to the skin will be seen best. In fact, all layers from skin to skin contribute to the final "flat drawing." The structures in the various layers may cause difficulty in interpretation because of *superimposition*, as in an oblique view of the skull. Another, and more treacherous occurrence, is the *summation* image, in which, because of insufficient heterogeneity of contrast between structures, only some of them are shown, while others are entirely lost. Franke (Germany) has proved that the delicate bone trabeculation remains

unchanged if two femoral heads are superimposed on one roentgenogram, provided adequate provision is made in the exposure factors. A hole, or canal, in the bone cannot be seen unless there is also a cortical defect. If the femoral head is cut in sections, parallel to the plane of the cassette, and these sections are superimposed at random, some face-up and others face-down, one is still unable to see any change on the roentgenogram, and the "lines of force" in the femur remain unaltered. Every aspect on the summation image (cholelithiasis, miliary pulmonary spread) corresponds to a real structure, and can be identified at surgery or autopsy, but many details (some of the gallstones, a large number of miliary elements) are invisible.

The opinion has been expressed that subliminal structures (those which do not appear on the roentgenogram if exposed separately from the others, with the same factors) are invisible on summation images, but this is refuted in the present paper. The authors believe that, by apposition, these structures will act as radiation absorbers and may thus become visible. The factors which decrease the summation effect are those which lower the contrast: (1) secondary radiation (a grid is a prerequisite for a sharp summation image), (2) screen unsharpness, (3) large focal spot, and (4) body-section technic. Contrary to the common belief, bone trabeculation can be demonstrated on tomographic studies which are, paradoxically and so far unexplainably, the best available method to separate the components of a summation image, for instance to demonstrate a cavity within the spongiosa. The problem is of considerable significance to those using roentgenography, because summation is a major source of intrinsic artefacts.

Seventeen figures.

E. R. N. GRIGG, M.D.
Cook County Hospital, Chicago

RADIOTHERAPY

Pituitary Radon Implant for Advanced Cancer. A. P. M. Forrest, D. A. Peebles Brown, Sasha R. Morris, and C. F. W. Illingworth. Lancet **1**: 399–401, April 14, 1956. (University Department of Surgery, Western Infirmary, Glasgow, Scotland)

In an earlier report two of the authors described a method for destroying the pituitary gland by radon seeds inserted by means of a cannula through the nostril and sphenoidal sinus (Lancet **1**: 1054, 1955. Abst. in Radiology **66**: 477, 1956). During 1955 the procedure was employed in 25 cases of advanced cancer of the breast and 8 of cancer elsewhere in the body. All of the patients had advanced malignant neoplasms, with metastatic spread to lymph nodes, bones, lungs, and in 1 instance to the brain. In all the tumor had progressed despite surgery and/or radiotherapy, or had been deemed unsuitable for such treatment. Several patients had been treated by hormones without benefit.

In the first 26 cases the original technic was followed. In the last 7 two cannulas were used, one through each nostril, and two seeds, each of 8 mc, were inserted so as to lie symmetrically, one on each side of the mid-line. There have been no deaths attributable to the treatment. The immediate course has been uneventful except for transient headache in a few patients. The only complication—a formidable one—has been radiation damage to the optic tract. In 4 patients defects of one visual field appeared one to four months after the implant. In 3 the damage progressed to complete loss of sight of one eye; in the 4th blindness ensued. No other patient in the series had shown any evidence of visual tract damage at the time of the report.

After insertion of a sufficient dose of radon, hypopituitarism develops in a few weeks. The urinary excretion of 17-ketosteroids falls to 1 mg. or less per day, and the output of follicle-stimulating hormone to near zero. Cortisone is required, usually to the extent of 25 mg. daily. Some patients after a few months showed symptoms of hypothyroidism. One of the earliest and most constant hormonal effects has been the development of diabetes insipidus, with the severity of the polyuria depending on the amount of cortisone administered. It can be controlled readily by pitressin, either as a snuff or as the tannate in oil. The polyuria tends to diminish after a few months.

In the 8 cases of neoplasm other than cancer of the breast the implantation of radon seeds was entirely ineffective. Nine of the 25 patients with breast cancer died of progressive malignant disease, and 9 others showed no improvement, though it is possible that in some of them treatment was too recent for assessment. Seven patients derived sustained benefit from the treatment, and their histories are given in brief.

There is no doubt that in some cases destruction of the pituitary gland by implantation of radon seeds resulted in relief of pain (particularly from skeletal metastases), in recalcification of the affected bones, in shrinkage of soft-tissue deposits, and even in a reduction in size of the primary growth. The authors cannot yet determine the extent to which these responses depend on individual variations in "hormone dependence" of the tumors or on the completeness of the pituitary destruction.

The practical problem for the immediate future is to devise a reliable method of destroying the pituitary gland completely without damaging the optic tract. To some extent this may be accomplished by increasing skill in the technic of implantation; the use of a less penetrating isotope, such as yttrium 90, may also prove advantageous. It may be that loss of sight will have to be accepted as an unavoidable risk, worth taking only as an alternative to loss of life.

Two roentgenograms; 2 photographs; 1 photomicrograph; 2 graphs.

Pinealoma with Metastases in the Central Nervous System. A Rationale of Treatment. Fred D. Fowler, Eben Alexander, Jr., and Courtland H. Davis, Jr. J. Neurosurg. **13**: 271–288, May 1956. (F. D. F., Children's Medical Center, Boston, Mass.)

A review of the literature indicates the metastatic potentialities of pineal tumors and other brain tumors arising in the pineal region. The authors note that all previously reported cases of extracranial spread have occurred in patients undergoing direct surgical attack on the tumor and theorize that this may have played a part in allowing malignant cells access to the circulation.

Three personal cases are reported in considerable detail. The neurological findings were diffuse and

varied, but a typical tumor was demonstrable in the posterior portion of the third ventricle on ventriculographic study.

The first patient, a ten-year-old boy with polydipsia and polyuria, was explored through the posterior fossa following clinical and ventriculographic study. A pink-white fleshy nodule was found adherent to the left cerebellar hemisphere and a similar tuft of tissue protruded from the lower end of the aqueduct of Sylvius. The cerebellar nodule was removed and supportive therapy with ACTH and cortisone was given for seven days. The pathologic diagnosis was pinealoma. Following surgery, radiation (220 kv, 0.5 mm. Cu and 1.0 mm. Al filtration) was given for an air dose of 1,800 r through each of two lateral ports directed to the pineal region, over a twelve-day period; an air dose of 1,700 r through each of four portals was delivered to the spinal column in eighteen days. The boy remained essentially well during a twelve-month follow-up.

The second patient, a nineteen-year-old boy, underwent posterior fossa exploration and ventriculocysternostomy, with moderate postoperative roentgen therapy directed toward the posterior portion of the third ventricle. Over a carefully controlled follow-up period of more than three years, there developed, in turn, metastatic foci in the lumbar region, in the mid-cervical spine, and in the region of the hypothalamus. Decompression laminectomy, followed by moderate doses of roentgen therapy, resulted in complete disappearance of the spinal metastases, with re-establishment of spinal-fluid pathways and resolution of blocks.

The third patient, a twenty-year-old girl, was found at exploration of the posterior fossa to have tumor metastases in the vermis of the cerebellum. Ventriculocysternostomy and postoperative roentgen therapy resulted in approximately one-year survival in reasonably good health. Further roentgen therapy was then given to the posterior fossa because of clinical evidence of progressing tumor and the patient failed rapidly. Postmortem studies showed changes in the cerebellum and brain stem thought by the neuropathologist to be secondary to radiation rather than tumor, although the point is not clearly made.

It is concluded that tumors arising in the pineal (histologically mostly teratomas or teratocarcinomas) have potent propensities for spread throughout the central nervous system along cerebrospinal fluid pathways. Consequently, the treatment of choice appears to be conservative ventriculocysternostomy, with biopsy whenever feasible, followed by roentgen therapy to the entire brain-spinal cord axis. The authors do not state their roentgen therapy doses precisely but the figures suggest a rather moderate dosage. The data indicate that results obtained with decompression and irradiation are superior to those following radical surgery.

The interesting point is made that spinal fluid studies on pineal tumor cases frequently show an increase in "round cells." These may be easily confused with lymphocytes but in actuality are free-floating tumor cells.

The most frequent sites of tumor spread are the suprachiasmatic structures and cauda equina.

Five roentgenograms; 4 photomicrographs; 1 table.

JAMES W. BARBER, M.D.
Cheyenne, Wyo.

Contribution to the Clinical Features, Prognosis, and Therapy of Struma Maligna. Eberhard Scherer, Hans-Joachim Fiebelkorn, and Bruno Göbel. Strahlentherapie **100:** 34–55, May 1956. (In German) (Strahleninstitut und der Strahlenklinik der Universität Marburg/Lahn, Germany)

In recent years thyroid cancer has been discovered with increasing frequency. It is found in 5 to 10 per cent of all nodular goiters. Malignant changes may arise in adenomas as well as in chronic inflammatory conditions, and sudden growth of solitary tumors is more suspicious of malignancy than the development of multiple nodes. The diagnosis of carcinoma is frequently made only at operation. Storage of radioiodine depends on the histologic structure of the tumor, highly differentiated tumors accumulating more than the anaplastic types. The prognosis is generally poor, especially in rapidly growing tumors. The average survival is two years for carcinoma and only six months for sarcoma. Metastatic spread is not necessarily ominous, especially in the case of metastasizing adenoma, Langhans struma, and the malignant papilloma.

Seventy-three cases of thyroid cancer observed between 1942 and 1954, are evaluated in this report. Of these cases, 75 per cent had a goiter history. Radioiodine therapy was disappointing in most instances. Because of their radiosensitivity, the following tumor types have been considered for radiotherapy only: Langhans struma (the only radioresponsive form of differentiated adenocarcinoma), undifferentiated adenocarcinoma, parastruma maligna, sarcoma, lymphoblastoma, and other mesenchymal malignant tumors. Primary operation with postoperative radiotherapy is indicated in all differentiated adenocarcinomas (papillary and follicular forms) and in the metastasizing adenoma. Additional neck dissection is also recommended, especially in papillary adenocarcinoma Removal of non-toxic goiter nodes in endemic areas is of doubtful value. Only in goiter areas where the rate of thyroid carcinoma is unusually high would a prophylactic thyroidectomy be justifiable.

The five-year survival rate in the authors' series was 16 per cent, but more than 50 per cent of the cases were already in an advanced stage with metastatic spread when first seen. It is believed that, with the help of an early histologic diagnosis and individual planning of therapy, with or without combination of methods, the results can be improved.

Twelve tables.

ERNEST KRAFT, M.D.
Northport, N. Y.

Etiology and Radiation Treatment of the Middle-Lobe Syndrome. O. Fischedick. Radiol. clin. **25:** 164–170, May 1956. (In German) (Knappschafts-Krankenhaus, Westerholterweg 82, Recklinghausen (Westf.), Germany)

The author reports 41 cases of middle-lobe syndrome, 38 in men and 3 in women. While many of these patients also had silicosis, a causal relationship between the two conditions could not be established unquestionably. The material offered no new indications as to whether a benign or malignant process was at the bottom of the middle-lobe atelectasis.

When surgical intervention is not to be undertaken, radiation therapy is used only when a histologic diagnosis has been made. Otherwise, the author advises a course of roentgenologic "watchful waiting."

Nine roentgenograms.

CHRISTIAN V. CIMMINO, M.D.
Fredericksburg, Va.

The Treatment of Primary and Metastatic Cancer of the Liver. Irving M. Ariel. Surgery **39**: 70–91, January 1956. (139 E. 36th St., New York 16, N. Y.)

Fifty patients with liver cancer who received radiation therapy, intra-arterial chemotherapy, isotope therapy, or a combination of these agents form the basis of this review.

Treatment of Cancer of Liver by X-Radiation: Most radiologists have been reluctant to administer radiation to patients with liver tumors in the belief that the liver is unduly sensitive to the effects of irradiation. In the author's opinion this concept is unfounded. Twenty patients in the present series were given a course of external irradiation as definitive therapy. Physical factors were 200 to 250 kv., h.v.l. 2 mm. Cu, 70 cm. target-skin distance, D/n 2,000 to 4,000 r. Between 250 and 300 r were given daily to each of four ports over a period of from three to five weeks. Treatment was tolerated well for the most part, with no untoward results and no excessive radiation sickness. In addition to a lipotropic supplement and vitamins, the patients were encouraged to take as large a quantity of food as possible.

Five of 10 patients with primary hepatic cancer had a good symptomatic response to irradiation, with an average duration of life of 3.5 years; the average duration of life in the other 5 was only five months. It would thus seem that the malignant nature of the primary tumor, with its inherent growth capacity and biologic effects, influences the results. The average duration of life in 10 patients with metastatic cancer of the liver was only seven months, with relief of symptoms for only a short time.

From his experience the author comments as follows: (1) The liver can tolerate irradiation well providing it has not been too badly damaged by cancer, nutritional deficiency, or associated diseases, and if the patient is not metabolically impoverished. (2) If the neoplasm does not occupy too great an area within the liver, then the beam of radiation, which will penetrate a limited segment of the liver, will be well tolerated. If the bulk of the liver is irradiated, radiation sickness will occur. Thus, diffuse metastases over the entire liver should not be given a radical course of radiation therapy. (3) The large quantity of blood circulating through the liver would make one expect a good response of liver tumors to irradiation. In the present series, patients who had a good hematopoietic reserve at the time of treatment tolerated it well with very little fall in red cell mass. In patients whose ability to fabricate blood is deficient, irradiation will have a deleterious effect. (4) With regard to radiation sickness, radiation therapy over the liver presented no problems other than those associated with irradiation over other parenchymal organs. (5) Liver cells which are starved suffer greater effects from irradiation and therefore every effort must be made to maintain a good hepatic metabolic state. (6) A peculiarity of liver response to irradiation is the paucity of fibrous tissue reaction. It has been demonstrated that the fibrotic response is an important feature in helping to control certain cancers. (7) The histologic form of the tumor markedly influences the degree of response. Thus, hemangiomas and neuroblastomas as well as the various lymphomatous infiltrations respond very well to x-ray therapy. Tumors originating from the cervix, bronchial carcinoma, etc., also respond fairly well. Adenocarcinomas react most poorly, and thus cancer metastatic from the stomach, rectum, pancreas, and breast does not show too great a response.

Intra-arterial Chemotherapeutic Agents in the Treatment of Liver Tumors: Fourteen patients with metastatic cancer of the liver were given nitrogen mustard (an average of 10 mg. per day for a total dose of 50 to 60 mg.) and the antibiotic, Terramycin (5 to 8 gm.), intra-arterially. The average duration of life was only five months, but certain of the patients enjoyed rather marked relief of symptoms. On the basis of observations of this group, the following statements are made. Extensive hepatic tumors replacing much of the liver respond poorly to intra-arterial nitrogen mustard and should not be so treated. This method of treatment is contraindicated in patients with marked hepatic abnormalities and in those who are metabolically impoverished. Results are usually poor in patients with ascites and in those with prolonged periods of obstructive phenomena in the liver with severe jaundice. The most favorable response was obtained in cases of ovarian and uterine origin. Patients with metastases from cancer of the gastrointestinal tract did poorly.

Effects of Intra-arterial Nitrogen Mustard Supplemented with Radiophosphorus: In 11 patients with metastatic cancer of the liver, nitrogen mustard was supplemented by radiophosphorus. It is difficult, however, if not impossible, to evaluate the contribution of the radiophosphorus to the benefits obtained. The average duration of life was only six months. Treatment was tolerated well if the patient has a good hematopoietic reserve at the onset of therapy; a profound anemia and leukopenia, which was difficult to control, developed in those with defective hemopoiesis.

Intra-arterial Nitrogen Mustard Followed by Deep X-Ray Therapy: Four patients received intra-arterial nitrogen mustard followed by irradiation. One received no benefit from the nitrogen mustard and the liver increased in size. When 300 r was administered to two ports on alternate days for a total of 3,000 r × 2, an excellent response was obtained and the liver became smaller. Ascites developed within a month, however, and death ensued seven months later. Another patient obtained a six months remission of all symptoms following treatment but died within one year. The third patient could not tolerate the treatment and it was discontinued. The fourth derived no benefit and died within six months.

Combined Treatment with Intra-arterial Nitrogen Mustard, P^{32}, and Deep X-Ray Therapy: Combined treatment consisting of intra-arterial nitrogen mustard plus radiophosphorus plus deep x-ray therapy was given 4 patients. One patient felt well for a period of six months following the initial treatment with nitrogen mustard but died ten months later from liver failure. The results in the other 3 patients are not given.

The present series of patients with cancer of the liver treated by combined chemotherapy and roentgen irradiation is too small for any definite conclusion. All of the patients died following treatment. Although the effect upon longevity in most of them is difficult to evaluate, 50 per cent of them experienced palliation. For patients who have metastases in the liver discovered at time of exploration, it is recommended that the primary cancer be surgically resected where possible, and an intra-arterial catheter be inserted into the femoral artery and delivered to the celiac axis. A course of nitrogen mustard should then be given, fol-

lowed by deep x-ray irradiation if the patient's metabolic status will withstand this therapy. Further investigation of the effect of radioisotope therapy is necessary before it can be recommended as a routine measure. The surgical treatment of tumors of the liver is discussed briefly.

Two photographs; 5 photomicrographs; 5 tables.

The Role of Irradiation in the Treatment of Wilms' Tumor in Children. H. Dabney Kerr and Robert E. Flynn. Am. J. Roentgenol. **75:** 971–976, May 1956. (R. E. F., 550 W. Thomas Rd., Phoenix, Ariz.)

The authors review the subject of Wilms' tumor, citing the contributions of various workers to the pathogenesis of the tumor, its age incidence, associated gross physical findings, histogenesis, and prognostic factors.

Five-year survivals have been reported with each of the following treatment procedures: (1) nephrectomy, (2) preoperative irradiation with nephrectomy, (3) nephrectomy followed by irradiation, (4) nephrectomy preceded and followed by irradiation, (5) irradiation alone. These cases, numbering 118, including 5 of the authors', are tabulated.

Also tabulated are 28 cases treated at the University of Iowa between 1931 and 1951, 14 of which have been previously reported (Kerr: J.A.M.A. **112:** 408, 1939). Prior to 1938 treatment was mostly by irradiation alone. Since that time, irradiation followed by nephrectomy is advised if metastasis cannot be demonstrated. Immediately following discovery of the tumor it is treated with 200-kv radiation (50 cm. focal skin distance, 0.9 or 1.9 mm. Cu half-value layer) directed to adequate anterior and posterior portals. For large tumors a lateral portal is added. Each of two portals receives 200 r in air, daily. The total air dose has ranged between 3,600 and 4,800 r, to provide a tumor dose of between 2,000 and 3,000 r. Eight to twelve weeks following the beginning of the irradiation a nephrectomy is done.

The authors believe that a two-year period free from recurrence is insufficient to establish a "cure" and cite from their own experience cogent reasons for their opinion.

Of 14 patients in the authors' series treated by irradiation alone, 4 survived two years (28.6 per cent) and 2 survived five years (14.3 per cent). Of 14 patients treated by irradiation and nephrectomy, 7 survived two years (50 per cent) and 5 survived five years (35.7 per cent); 4 are alive and well from five to nine years.

Energetic irradiation of metastatic foci or recurrences is recommended. H. C. JONES, M.D.
Grand Rapids, Mich.

The Differentiated Histologic Findings of Lymphogranulomatosis as Basis of Therapeutic Success. Hermann Trübestein. Strahlentherapie **100:** 62–71, May 1956. (In German) (Universitäts-Röntgeninstitut, Frankfurt am Main, Germany)

For the prevention of recurrences in lymphogranulomatosis, irradiation with a tumor dose of 2,000 r is necessary even though chemotherapy may be given simultaneously. In previous histologic studies it has been found that the prognosis is favorable when the tumor is rich in lymphocytes; when the tissue shows an abundance of reticulocytes the outlook is always bad. This conclusion has been challenged, however, since the histologic findings vary greatly even in individual sections of a single node.

The author studied 98 cases, of which 8 were paragranulomas, 11 transitional forms from paragranuloma to the typical granuloma, 74 typical granuloma, and 5 transitions from classical granuloma to Hodgkin's sarcoma. All cases were grouped into lymphocyte-rich and lymphocyte-poor types. The former type was seen mostly in paragranuloma and the latter in Hodgkin's sarcoma and in the transitional form of the classical lymphogranuloma.

In the lymphocyte-rich type survivals up to ten years were observed, whether radiation was used alone or in combination with chemotherapy. The prognosis remained favorable even when mediastinal nodes were involved as well as a group of peripheral nodes. In the lymphocyte-poor type survival was much shorter, regardless of whether the disease was still localized to one group of nodes or was already widespread. Poor results in the lymphocyte-rich type could usually be traced to inadequate initial therapy. In other instances it is believed that transition to the lymphocyte-poor type had already existed in an early stage, but could not be proved histologically.

For accurate type determination, biopsy of several nodes is necessary, but experience has shown that in localized lymphocyte-rich lesions a combination of the two types is unlikely. The author concludes that, though two cases may be exactly alike clinically, as to extent of node involvement and intensity of therapy, the lymphocyte-rich case will show a much longer survival than the lymphocyte-poor case.

Two tables. ERNEST KRAFT, M.D.
Northport, N. Y.

Tissue Equivalent Ionization Chambers. Harald H. Rossi and G. Failla. Nucleonics **14:** 32–37, February 1956. (Department of Radiology, Columbia University, New York, N. Y.)

The authors present the results of a number of years of experience in the design of tissue-equivalent ionization chambers. Such chambers contain in their walls and in the gas filling them the significant elements occurring in tissue, in the correct proportion, and thus may be used for the determination of absorbed dose of any ionizing radiation. Also described are chambers which exhibit tissue-like response to some radiations while remaining relatively insensitive to others, the purpose here being to differentiate between components of different biological effectiveness, as is necessary in the case of radiation from a nuclear reactor.

A tissue-equivalent material, in the form of a gel, is described, along with the gas mixture for a tissue-equivalent chamber filling. Using the gel chamber as a standard, a conducting plastic was developed having substantially tissue-equivalent properties but better physical characteristics.

Design details of chambers for various uses are given, including one for personnel protection, one for very high doses (up to 4,000 rads), and one for thermal neutron measurements.

Finally, a method of calibration for neutrons is described. This is based on the fact that when tissue is exposed to 1 r of reasonably hard x-rays (250 kv, 2 mm. Cu filtration) 93 ergs are absorbed per gram. After making a correction for the difference in W between protons and electrons, the chamber may be calibrated in terms of rads (100 ergs/gm.) for neutrons.

Seven figures. ROSS GARRETT, M.Sc.
Memorial Center, New York

Monitoring Filters in Roentgen Therapy. R. Thoraeus. Acta radiol. **45:** 414–420, May 1956. (Institute of Radiophysics, Karolinska Sjukhuset, Stockholm, Sweden)

The author calls attention to the fact that a composite filter, such as he devised in 1928, may be modified so as to serve as a monitoring filter. He then points out how the measuring properties of a monitoring filter may be varied both qualitatively and quantitatively. Every effort must be made to eliminate variations which may occur in the monitoring current as a result of fluctuations in temperature and the pressure of the gas enclosed in the chamber. To eliminate these variations the filter monitor must be gas tight and reliably sealed. Means of modifying the sensitivity are cited. By connecting the monitoring filter to an integration mechanism the amount of radiation emitted by the tube and that received by the patient can be recorded.

If two or more different filters are constructed as monitoring filters, the ionization current may be used to characterize these and thus distinguish between them. These filters may be multipurpose in design and operation.

In a previous paper (Benner et al: Acta radiol. **43:** 65, 1955. Abst. in Radiology **65:** 825, 1955), the equipment for precision rotation therapy technic used at the Radiumhemmet was described. Two essential requirements were stressed: (1) keeping the dose rate of the primary beam as constant as possible; (2) checking the constancy of the dose continuously during each treatment. To meet these requirements, a monitoring filter devised by the author has been in use since 1953. The added filter in use at the Radiumhemmet is 0.2 mm. Cu plus 1.0 mm. Al. By designing this as a monitoring filter definite advantages have been gained. It is so constructed that the continuous screening control may be interrupted and the relationship of the patient to the beam determined under ordinary screening conditions. When it is desired to do this, the tube voltage and current are reduced from 200 kv and 20 ma to the requisite values and the monitoring filter is removed by remote control. As long as the monitoring filter is out of its usual position, the tube voltage cannot be raised above 100 kv. When the special screening is finished the filter is returned to its original position by the remote control apparatus which removed it. Not until this has been done can the tube voltage be raised to its original level.

The monitoring current is measured by the direct method, with a sensitive microammeter of reliable constancy. To avoid fluctuations which might result from variations in temperature and pressure, the filter is hermetically sealed.

This filter has performed very satisfactorily. Under test conditions the dose rate measurements showed a constancy within ±1.2 per cent and the ionization current in the monitoring filter was found to be constant within ±1 per cent.

Five photographs; 4 graphs.

H. C. JONES, M.D.
Grand Rapids, Mich.

RADIOISOTOPES

The Role of Radioactive Iodine in the Diagnosis of Thyroid Disease. J. E. Rall. Am. J. Med. **20:** 719–731, May 1956. (National Institute of Arthritis and Metabolic Diseases, National Institutes of Health, Bethesda, Md.)

The author analyzes briefly the major known reactions that take place during the formation, release, and degradation of the thyroid hormone and suggests how these reactions may be measured by radioactive iodine tests of thyroid function. In five tables, he tabulates the results that have been obtained by various investigators employing seven different radioiodine tests in various thyroid states.

Indirect studies of the iodine concentrating mechanism of the thyroid, such as the one-hour uptake or the twenty-four-hour uptake tests, measure the net result of both thyroid and renal function. The results of such radioiodine tests are affected by the renal status of the patient and by the dietary intake of iodide.

The author discusses the intrathyroidal "organification" of iodide and states that the competence of this step is relatively easily determined. Following the administration of the tracer dose of I^{131}, potassium thiocyanate or perchlorate is given and the remaining inorganic iodide in the thyroid is discharged. The residual thyroid activity, therefore, constitutes a measure of the radioiodine which has been incorporated into complex organic molecules within the thyroid gland. It is pointed out that some patients with hyperthyroidism previously treated with radioiodine may continue to have elevated one- and four-hour thyroid uptakes in the presence of secretion of the normal amount of thyroid hormone. The explanation for this fact rests upon the relatively greater effect of irradiation on the organification step in intrathyroidal iodine metabolism, the iodide trapping rate remaining relatively the same. The author mentions higher steps in the organification of iodine and some rather complex radioiodine tests which may be used to evaluate possible defects at these levels.

Many ways have been proposed to measure more or less directly the rate of secretion of thyroid hormone iodine, using I^{131}. In all instances, measurements of the specific activity, usually of the protein-bound iodine in the blood, are necessary, and in all cases serial measurements of thyroid, blood, urine and sometimes fecal radioactivity are required. From a practical standpoint, it seems probable that with present methods a more reliable index of thyroid function is provided indirectly by measurement of some aspect of thyroid accumulation of radioiodine, as for example the plasma thyroid iodide clearance rate.

The author discusses post-thyroid iodine metabolism, commenting upon the degradation of thyroid hormone, the excretion of thyroid hormone, alterations in the thyroid-hormone-protein complex in serum, and upon tissue sensitivities to thyroid hormones.

Three cases are cited in which the diagnostic problem was complicated by the nature of previous treatment, both medical and surgical, illustrating that in an individual case it is sometimes difficult to distinguish an inherent abnormality of thyroid function from changes in thyroid status induced by previous treatment.

The importance of clinical experience and acumen in

the diagnosis of thyroid disease is stressed. Laboratory measurements indicative of thyroid function are only adjuncts to proper evaluation of the thyroid status.

Finally, the author points out that the thyroid gland receives approximately 15 rep from a 10-microcurie dose of I^{131}; this represents the amount of radiation that would normally be permitted as "the maximum permissible safe dose" for an entire year. A plea is made for caution and common sense in the use of radioiodine tests and it is suggested that the use of I^{132} (half-life 2.3 hours) in certain tests may allow reduction of the amount of irradiation delivered to the thyroid gland.

Five tables.

JAMES E. BAUER, M.D.
University of Missouri

A Radioiodine Uptake Test and Its Application in Clinical Diagnosis. F. F. Rundle, W. A. Seldon, and J. S. Indyk. M. J. Australia **1:** 732–736, May 5, 1956. (The Royal North Shore Hospital of Sydney, Sydney, Australia)

The authors describe their experiences with a simple test of iodine uptake in thyroid disorders. It is based on the rate and amount of I^{131} accumulation in the thyroid gland within the first hour following injection of a tracer dose intravenously. Thyroid uptake is measured by expressing the count of radioactivity over the thyroid (neck count) as a function of the general body background (thigh count), namely, as the neck/-thigh ratio (N/T). The isotope is administered in 10-microcurie doses and a simple counting apparatus is employed.

The authors' material comprised 135 consecutive I^{131} uptake tests carried out in 121 patients, all of whom were referred as presenting thyroid problems.

The usefulness of the procedure as a diagnostic test rests chiefly on the clear differentiation of patients with anxiety states from those with definite thyrotoxicosis. Determination of the N/T ratio may be useful also in cardiac patients when it is essential to exclude any possibility of thyrotoxicosis and when dyspnea would vitiate estimations of the basal metabolic rate. When iodine intake is normal, a low value for the N/T ratio may be accepted as positive evidence of the absence of thyrotoxicosis. But high readings, within the thyrotoxic range, have also been found in euthyroid patients under thiouracil therapy, and four months or more after effective I^{131} treatment for thyrotoxicosis.

One photograph; 5 figures.

Physiologic Concepts in the Diagnosis and Treatment of Graves' Disease. Brown M. Dobyns. Am. J. Med. **20:** 684–697, May 1956. (Department of Surgery, Western Reserve University, Cleveland, Ohio)

The author describes the clinical picture seen in cases of Graves' disease and recalls the original descriptions of Graves and von Basedow. In Graves' disease, the hyperfunctioning tissue comprises all the non-adenomatous thyroid tissue, whereas in toxic nodular goiter, hyperfunction is attributable to the nodules (radioautographs are reproduced to illustrate this concept). These two conditions also differ in respect to their general behavior effects, exophthalmos, and response to iodine therapy.

The relationship between thyroid-stimulating hormone and Graves' disease is discussed in the light of findings by various investigators. It appears most likely that the thyroid produces independently an excess of thyroid hormone and that the pituitary responds by decreased production of thyroid-stimulating hormone.

Other aspects of the subject claiming the author's attention are: structural changes in the thyroid associated with Graves' disease and the involutional effect of iodine administration; the occurrence of peripheral lymphocytosis and lymphocytic infiltration; the nature of the thyroid hormones and the method of their manufacture by the gland; anti-thyroid compounds in the treatment of Graves' disease, particularly in relation to thyroid physiology; the general concepts of surgery in the treatment of Graves' disease.

In discussing the problem of exophthalmos, it is suggested that eye signs be divided into two groups: (1) those which occur with Graves' disease, and (2) those which occur with thyrotoxicosis of any type or with hypothyroidism. The exophthalmos-producing substance from the pituitary has been shown to be separable from thyroid-stimulating hormone.

Four figures, with 2 radioautographs.

JAMES E. BAUER, M.D.
University of Missouri

A Lingual Goiter Treated with Radioactive Iodine. J. Einhorn and L.-G. Larsson. Acta radiol. **45:** 405–413, May 1956. (General Department of Radiumhemmet, Karolinska Sjukhuset, Stockholm, Sweden)

The authors report the case of a 66-year-old male with a lingual goiter appearing eight years after the removal of a nodular, partly intrathoracic goiter.

In January 1954, about eight years after thyroidectomy, the patient experienced bleeding from the nose and mouth and a sense of swelling in the throat. In February 1954, a spherical tumor about the size of a walnut was discovered at the base of the tongue. Biopsy revealed alveolar and follicular structures, considered indicative of lingual thyroid. Electrocoagulation was performed twice but was followed by a rapid regrowth of the tumor.

In May 1954, a tracer dose of I^{131} was given, with uptake limited to the tumor at the base of the tongue, now 4 cm. in length. The uptake was 48 per cent at the end of twenty-four hours. The basal metabolism rate was 19 per cent, and serum cholesterol was 263 mg. per cent.

On May 23 the patient was given a therapeutic dose of 80 mc I^{131}. On examination at the end of August, basal metabolism rate was −13 per cent and the serum cholesterol 461 mg. per cent. The tumor had diminished to the size of a hazelnut. Uptake of I^{131} in the lingual goiter was 2.3 per cent and there was still no uptake in the neck or mediastinum.

The patient was again seen in November, with definite evidence of myxedema. A new tracer test showed 5.2 per cent uptake by the tumor and a second therapeutic dose (70 mc) was administered. In January 1955 repeat tracer studies failed to reveal any uptake in the tongue, neck, or upper part of the mediastinum. On subsequent examinations, in April and July 1955 and January 1956, no remnant of lingual goiter could be found on physical examination or by I^{131} studies.

The authors review the literature and discuss the embryology of aberrant goiter, as well as the type of treatment usually recommended. Despite the good therapeutic result obtained in this patient, they do not recommend I^{131} for routine use in the treatment of lingual goiters.

Two roentgenograms; 3 photographs; 1 photomicrograph.

J. P. CHAMPION, M.D.
Grand Rapids, Mich.

Two Ways to Estimate Thyroid Dose from Radioiodine in Fallout. Gordon M. Dunning. Nucleonics **14:** 38–41, February 1956. (Division of Biology and Medicine, U. S. Atomic Energy Commission, Washington, D. C.)

It is important to be able to estimate thyroid dose when inhalation or ingestion of radioactive fallout occurs. This paper describes a procedure for determining thyroid dose due to radioiodine, given the present activity or the initial intake.

For low yield detonations, such as those in Nevada, essentially all of the calculated intake by inhalation occurs within the first twenty-four hours for nearby communities. For detonations at the Pacific proving ground, activities in the air may persist somewhat longer in the United States. Thus, for relatively early, short exposures, the amount of intake by inhalation may be comparable to that by ingestion.

The problem of dosage calculation is complicated by the presence, at early intervals after detonation, of short-lived iodine isotopes and tellurium, which decays to iodine. The general approach is to calculate the dose from I^{131} and its precursors and then add to this the contribution from the short-lived isotopes.

All the necessary data for making calculations is given, along with two examples. In one, the thyroid dose received by sheep near the Nevada Test Site is calculated. Fallout occurred in the area where the sheep were grazing about three and a half hours after the nuclear detonation. About three weeks later the measured concentration of iodine in the animals' thyroids was about 5×10^{-2} $\mu c/gm$. The calculation shows that the total thyroid dose received is about 350 rep.

The second example concerns human inhalation. On May 19, 1953, the highest concentration of activity in the air due to fallout that has ever been recorded in the United States outside the Nevada Test Site occurred at St. George, Utah. It amounted to about 1.3 $\mu c/m^3$ averaged over twenty-four hours. The sample calculation given shows that the total radiation dose to the thyroids of the inhabitants from inhalation of the isotopes of iodine was 0.302 rep.

Three figures; 3 tables.

ROSS GARRETT, M.Sc.
Memorial Center, New York

An Evaluation of Peripheral Arteriosclerotic Insufficiency Utilizing Radioactive Iodinated Human Serum Albumin. Earl J. Halligan, Jonathan C. Gibbs, Jr., R. Vincent Grieco, and James E. McKeown. Surg., Gynec. & Obst. **102:** 511–516, May 1956. (Jersey City Medical Center, Jersey City, N. J.)

Radioactive iodinated human serum albumin (RIHSA), used as a tracer substance to study peripheral vascular disease, gives promise of putting such investigations on a quantitative and objective basis. Studies of the peripheral circulation of the lower extremities were made on 75 patients grouped according to the clinical and arteriographic findings. A group of patients with no demonstrable evidence of vascular disease was included.

The patient is placed in a recumbent position and 40 microcuries of radioactive iodinated human serum albumin, 1.0 c.c. in volume, is injected into the antecubital vein. Scintillation counts are done over the medial malleolus. When the injection is completed, the counts per minute, recorded graphically by an Esterline-Angus plus count rate meter apparatus, show a gradual increase to a point where they become more or less constant. The period of time from the initial increase in counts per minute above background to constant level, or plateau, is termed the time of equilibrium, and from this the circulation index is derived.

After equilibrium is established, the number of counts for one-minute periods is taken over the ankle, calf, and thigh. These are compared to readings taken over the femoral artery near the inguinal ligament and converted to percentages. The ankle counts were found to be the most useful and the comparison of ankle to femoral counts is designated "ankle to femoral (A/F) ratio." Using the findings in the normal patients as a base and judging the isotopic data in conjunction with clinical, radiologic, and pathologic observations the circulatory status of the extremity was evaluated. Figures and graphs for various stages of the occlusive disease of the lower extremities were obtained. The method was also used to determine the effect of different medications and operative procedures in arteriosclerosis obliterans. The authors conclude that:

"1. This method is more accurate than other clinical methods currently available in evaluating the circulation.

"2. This method is safe and relatively simple and may be repeated for diagnostic as well as prognostic purposes.

"3. The circulation of an extremity may be more efficiently determined by analyzing the circulation index, the build-up curve, and the A/F ratio.

"4. It has shown promise as a method of study of the reserve vascular bed and of ways to alter it, such as intra-arterial medications and lumbar sympathectomy.

"5. As a result of studies with this method, it is believed that vasodilator drugs may be continued after sympathectomy.

"6. The use of sympathectomy in patients with arteriosclerosis obliterans should be limited to those individuals with moderate disease, embolism, and vasospastic conditions."

Four roentgenograms; 2 graphs; 1 table.

MORTIMER R. CAMIEL, M.D.
Brooklyn, N. Y.

An Experimental Study of Intrahepatic Distribution of Portal Blood. Jack W. Cole, Jack Krohmer, Frederick J. Bonte, and William Schatten. Surg., Gynec. & Obst. **102:** 543–544, May 1956. (University Hospitals of Cleveland, Cleveland, Ohio)

It has been claimed that venous blood from different abdominal organs drains to particular portions of the liver. However, in the absence of any known morphologic, histologic, or cytochemical differences between the various lobes of the liver, this seems implausible.

To settle this problem, twelve experiments were performed on mongrel dogs. Ten to 25 microcuries of radioactive-iodine-labeled rose bengal dye, dissolved in saline, was injected into the smallest possible venous radicles in sites representing four different areas of the portal venous system: the small intestine, spleen, cecum, and left colon. Scintillation counts were then done over the right and left lobes of the liver. If the theory of separation or selective distribution of portal blood within the liver were true, the counts would be

expected to be different. In the cases tested, however, no significant differences were noted in the amount of dye or the rate at which peak values were attained between the right and left sides of the liver. In the light of these findings, it seems unlikely that venous blood from a particular portion of the portal bed is destined to be transported to a specific area within the liver parenchyma.

One illustration. MORTIMER R. CAMIEL, M.D.
Brooklyn, N. Y.

Investigation of Transfer Rates of Albumin Tagged with I^{131} in Ascites and Edema. II. Studies in Control Subjects and Patients with Cirrhosis. James A. Schoenberger, George Kroll, Edward L. Eckert, and Robert M. Kark. J. Lab. & Clin. Med. **47:** 227–240, February 1956. (Research and Educational Hospitals of the University of Illinois, Chicago, Ill.)

The concentration of radioactivity in the plasma and ascitic fluid following intravenous or intraperitoneal injection of albumin I^{131} was studied in 10 control subjects and in 6 patients with Laennec's cirrhosis. Graphic representation of the data and mathematical analysis of the curves made it possible to calculate the transfer rate of albumin in the plasma and ascitic fluid. Repeat studies in patients with cirrhosis during treatment disclosed a significant decrease in the exchange rate in 1 case. In 3 control subjects and in 1 cirrhotic patient, 2 rates of distribution of injected radioactive albumin from the plasma into the extravascular compartment were observed. The data suggested that extravascular albumin exists in several pools, each with a characteristic size and exchange rate.

Five graphs; 4 tables.

The Early Disappearance of I^{131} Serum Albumin from the Circulation of Edematous Subjects and Its Implications in the Clinical Determination of the Blood Volume. T. W. Moir, W. H. Pritchard, and A. B. Ford. J. Lab. & Clin. Med. **47:** 503–512, April 1956. (School of Medicine, Western Reserve University, Cleveland, Ohio)

The disappearance rate of I^{131} serum albumin from the circulation of 10 subjects with severe generalized edema was studied by a recirculation technic utilizing continuous arterial flow of blood past a scintillation crystal. Regardless of the etiology of edema, the disappearance slope was exponential after mixing, up to at least one hour. Loss of iodinated (I^{131}) albumin, expressed as a percentage of the initial theoretical concentration at zero, appeared to be no greater than in a group of normal persons studied previously. The average mixing time in the present group of patients was longer than in the group without edema.

Blood volume was significantly elevated in subjects with edema of cardiac origin and significantly reduced in those in whom edema was of nephrotic or cirrhotic origin.

In the employment of albumin-tagged substances for blood volume determinations in patients with edema, samples drawn after thirty minutes and up to one to two hours should give a single exponential slope from which accurate calculations can be made. The practical expedient of drawing four samples at ten-minute intervals in the thirty to sixty minute period following injection is recommended.

Four graphs; 5 tables.

Determination of Protein-Bound Radioiodine with an Anion Exchange Resin. Leslie Zieve, William C. Vogel, and Alvin L. Schultz. J. Lab. & Clin. Med. **47:** 663–668, April 1956. (Department of Medicine, University of Minnesota, Minneapolis, Minn.)

The standard procedure for determination of protein-bound radioiodine of plasma involves counting of the washed precipitate of plasma proteins. Trichloroacetic acid is the usual precipitating agent employed. This method proved to be inadequate in washing away a great excess of inorganic radioiodine. An alternative method utilizing an anion exchange resin column was therefore explored, since resins had been used successfully in removing excess radioiodine during the preparation of iodinated serum albumin. The resin column procedure was found to be both simpler and more valid. The findings were as follows:

With the trichloroacetic acid procedure, approximately 3 per cent of the protein-bound radioactivity is lost with each wash, with a total loss of about 15 per cent. By the end of the second wash, over 90 per cent of the radioactivity in the wash solution is butanol-extractable.

Passage of plasma through a column of Amberlite resin was found to remove inorganic iodine efficiently. Protein-bound iodine is also lost, averaging approximately 4 per cent; this is partially compensated for by the loss of a small amount of water by the plasma in its passage through the resin column, with the protein concentration of the effluent increasing by about 1 to 2 per cent. Eighty to 90 per cent of the radioactivity retained by the column was removed by the first 3 cm. of the 21-cm. resin column, and 5 to 20 per cent by the last 18 cm. One passage of plasma through a resin column yields protein-bound radioiodine values that differ by an average of 4 per cent from those obtained with dialysis. Conversion ratios based upon resin values were essentially similar to those obtained with dialysis, being 1 per cent lower on the average.

The Determination of Protein-Bound $Iodine^{131}$ with Anion Exchange Resin Column. Theodore Fields, David S. Kinnory, Ervin Kaplan, Y. T. Oester, and Everett N. Bowser. J. Lab. & Clin. Med. **47:** 333–336, February 1956. (Radioisotope Unit, VA Hospital, Hines, Ill.)

In a previous study, determination of protein-bound I^{131} in human blood plasma was made by removing inorganic $iodide^{131}$ from PBI^{131} using Amberlite anion exchange columns (see preceding abstract). In order to determine the reliability of this method, a direct comparison of the procedure with the trichloroacetic acid precipitation technic (TCA) was undertaken in 100 consecutive thyroid function studies. A close agreement between the results of these two methods was established. The considerable saving in technicians' time afforded by the use of the anion exchange resin column recommends this reproducible and simplified procedure as a valuable addition to the technics of thyroid diagnosis.

The average ratio of PBI^{131} by ion exchange to PBI^{131} by TCA method was 104 per cent. The ranges of values expressed as per cent of administered dose per liter of plasma were comparable to those previously reported. The protein-bound $iodine^{131}$ per liter of plasma of euthyroid patients contained less than 0.128 per cent and that of hyperthyroid patients more than 0.16 per cent of the administered dose I^{131} activity.

Study of the Lymphatics of the Mammary Gland with Radioactive Gold (Au-198). Felix E. Leborgne, Raul Leborgne, Eduardo Schaffner, and Felix E. Leborgne, Jr. Acta radiol. Interamericana **6:** 13–23, January-February-March 1956. (In Spanish) (F. E. L., Ibicuy 1210. Montevideo, Uruguay)

The authors, whose special interest in disorders of the mammary gland has long been known, have taken advantage of radioactive gold in advancing their knowledge of the pathways of spread of mammary carcinoma. Our information on the mammary lymphatics has been acquired largely from studies carried out on cadavers, with technics developed by anatomists. In recent years functional studies have been realized, constituting an important forward step. Mörl in 1948, employing Chinese ink in patients with very advanced lesions, was able later to observe lymphatic dissemination in the cadaver. Other efforts of this type are cited.

The present contribution is based on 8 cases, 4 of which were submitted to radical operation. The tracer employed was colloidal Au^{198}, the use of which did not alter the body's physiopathologic conditions. The technic opens up a new field for investigation of the factors governing the spread of the various types of mammary tumors, since it permits an *in vivo* study of lymphatic drainage. Stable Au^{197} is activated in the nuclear reactor by a neutro-gamma reaction, yielding Au^{198}, with a half-life of 2.69 days and emitting beta radiation of 0.97 MEV and gamma radiation of 0.41 MEV. The gamma radiation permits detection of the progression *in vivo* of the material injected. Possible therapeutic applications are also suggested, thanks to the beta radiation.

Injection of 0.5 to 1.0 ml. of colloidal solution of Au^{198} (activity 1 to 6 mc) is made into the subcutaneous tissues of the breast under aseptic precautions, with a calibrated syringe provided with a lead shield. The site of injection varies in different cases according to the zone to be studied and the site of the tumor. It is convenient to inject in the subareolar tissue or in the vicinity of the tumor, marking the place with a dermographic pencil. The low activity and the short half-life of the colloid present no risk to the patient. The necessary precautions needed for handling the isotopes must be observed. Geiger counters may be used, but scintillation detectors are preferable, being much more sensitive to gamma radiation.

The topographic distribution of the Au^{198} was analyzed by various ingenious devices, some of which were original with the authors. The axillary lymph nodes were found far more active than the internal mammary and the supraclavicular chains. During radical mastectomy control of excision of nodes is possible by scanning the remaining tissues. This method is useful for detecting lymph nodes in the operative specimen. Histologic sections may be used for making autohistoradiograms; in some nodes where malignant tissue completely replaced the normal structure, no activity was detected. Some reflections are included on the possibility of employing radioactive gold as a therapeutic agent.

This article is well and interestingly illustrated and will well repay the effort to read it or have it translated.

Seventeen illustrations. JAMES T. CASE, M.D.
Santa Barbara, Calif.

Radioactive Gold in Malignant Effusions. Owen Millar and J. C. F. MacDonald. Canad. M. A. J. **74:** 783–788, May 15, 1956. (Toronto General Hospital, Toronto, Ontario)

The authors report their experiences with radioactive colloidal gold (Au^{198}) in the treatment of 101 patients with malignant pleural and peritoneal effusions. For the sake of convenience and economy, 4 patients are treated from each shipment on the day it is received.

A pleural or peritoneal tap is made with a No. 16 or 18 needle, the cavity is aspirated completely, and the colloidal gold is introduced. Two washes of 50 c.c. of saline are then forced through the system to reduce any residual activity within the equipment and also to assist in even distribution of colloidal particles in the cavity. Following injection, the patient's position is changed every five minutes for an hour. Dosage is begun at 35 mc for the chest and 75 mc for the abdomen.

Possible complications are interstitial injection (not encountered in the authors' series), leakage from the insertion wound, actual puncture of lung tissue, and spillage with resultant contamination.

Post-insertion investigations should be done after the colloid is evenly distributed but before the dose delivered is so great as to render senseless its removal in the event of loculation. From urine, fecal, and blood studies it is reasonable to assume that the larger amount of active material is deposited either in the serous surfaces or in the liver, spleen, and kidneys.

One hundred sixteen instillations were done in the 101 patients. The largest group was made up of cancer of the breast—43 patients with 50 instillations—with improvement in slightly less than half. Eighteen patients with carcinoma of the ovary received 21 instillations, but only a third of these produced any improvement. Sixteen patients had secondary carcinoma of the pleura or peritoneum of unknown origin. Half of the 20 insertions of gold in this group were judged as having some measure of success. The remainder of the series was made up of miscellaneous cases, including 2 of pleural effusion not proved to be associated with cancer. In neither of these was any benefit received. Results in lymphoma were quite disappointing, in view of the usual response to radiation. [This has not been our experience.—W. T. C. C.]

One factor which had a bearing on results was the early occurrence of death. In 21 cases, patients were judged as having died before sufficient time had elapsed for any effect to be demonstrable.

The following conclusions are reached: To obtain any results, the patients must be in reasonable health, not cachectic. The method should be used only when withdrawal of fluid results in prompt reaccumulation. Second insertions should not be done unless the first has clearly suppressed fluid formation for many months. The method holds reasonable (40 per cent) chance of relief of the distressing symptoms of persistent fluid reaccumulation in malignant disease. The most favorable responses have been in cases of cancer of the breast with persistent pleural effusion.

Four figures; 6 tables.

W. T. CADMAN CHAFFIN, M.D.
Mercy Hospital, Pittsburgh

Present Status of Treatment of Carcinoma of Prostate with Radioactive Materials. George J. Bulkley, John A. D. Cooper, and Vincent J. O'Conor. J. Urol. **75:** 837–845, May 1956. (G. J. B., 720 N. Michigan Ave., Chicago 11, Ill.)

This paper is an interim report on the progress of 44

patients treated with radioactive materials for prostatic carcinoma. Patients in whom the lesion was confined to the periprostatic bed, lymph nodes, and seminal vesicles were chosen as most favorable for the study but some with distant metastases were also treated in the hope that local shrinkage of the tumor would alleviate bleeding, sloughing, and bladder neck obstruction. Multiple needles were used to inject the dose into the tumor by way of the perineum with a finger in the rectum as a guide. The perineal rather than the supra- or retropubic route was chosen since it both diminished the morbidity and led to a more homogeneous distribution of the radioactive material throughout the tumor.

Thirty-four patients received radiogold, the dosage ranging from 45 to 180 mc. In this group there were 9 deaths. Seven of the 9 patients obtained temporary relief, consisting of a decrease in dysuria and softening of the gland as determined by rectal examination. Of the 25 survivors at the time of this report, 10 had extensive carcinoma with no objective or subjective relief. Of the 15 alive and doing well, 7 had undergone simultaneous orchiectomy and others had been given oral estrogen because of distant metastases; 4 had repeat injections of the isotope because of recurrence of a rectally palpable tumor. In all 15 there was improvement in obstructive symptoms as well as shrinking and softening of the gland.

Radiophosphorus and radioyttrium were given by the perineal route to 5 patients each, in the dosage of 1 mc per gram of estimated tissue, the total dose ranging from 21.5 to 39 mc for the chromic phosphate and from 19.5 to 39 mc for the yttrium chloride. Not only did the radiophosphorus have no effect on the tumor, but in 2 of the 5 patients multiple petechiae and ecchymoses developed, associated with thrombocytopenia and suppression of bone marrow. In the yttrium group 1 patient died of cancer, without benefit; 2 were alive without subjective or objective improvement; 2 showed softening and diminution in size of the tumor.

Urinary excretion of the isotope occurs largely during the twenty-four hours immediately following injection. In some cases as much as one-third of the total dose appeared in the urine within forty-eight hours. Much of this loss is due to injection close to or into the urethra and to excretion by way of the prostatic ducts. An alarming percentage of the isotope may appear in the circulating blood stream during the first few minutes following injection, particularly in the case of yttrium and phosphorus. Thus, 1 of the patients receiving radiophosphorus had more than 25 per cent of the total dose of 33 mc in the circulating blood within five minutes after the injection; thrombocytopenia and other signs of bone marrow suppression subsequently developed.

Extravasation of the radiogold around the rectum produced transient tenesmus, diarrhea, and bleeding in 2 patients. In another there were tenderness, edema, and redness at the base of the penis along with painful priapism, lasting for six months.

While radiogold and radioyttrium produce destruction of the tumor and healing by fibrosis, the effect is highly localized and they must be considered as palliative rather than curative under the present methods of use. Yttrium, though hard to produce and to obtain, is somewhat safer than gold for both patient and operator, since it is a pure beta emitter.

One graph; 5 tables. SAUL SCHEFF, M.D.
Boston, Mass.

Studies on Urinary Excretion of Vitamin $B_{12}Co^{60}$ in Pernicious Anemia for Determining Effective Dosage of Intrinsic Factor Concentrates. William R. Best, Wilfrid F. White, Kenneth C. Robbins, Wendell A. Landmann, and Sanford L. Steelman. Blood 11: 338–351, April 1956. (University of Illinois College of Medicine, Chicago, Ill.)

The authors' summary of this paper is quite inclusive of the material covered:

"Studies were made in pernicious anemia patients on the urinary excretion of $B_{12}Co^{60}$ after a small oral dose followed by a large parenteral injection of non-radioactive vitamin B_{12}.

"(1) Increasing doses of intrinsic factor concentrates give increasing excretions of radioactivity at low doses; little additional increase at moderate doses; and at times a subsequent diminution at excessive doses. Data on 34 tests of a particular intrinsic factor concentrate in 18 pernicious anemia patients tend to support an excretion proportional to the logarithm of intrinsic factor dosage at low to moderate levels, but do not exclude the possibility of a linear approach to a plateau.

"(2) Assay by hematologic response was compared with the urinary excretion tests in 13 pernicious anemia patients. The data show a relation between the two tests though the correlation is far from complete.

"(3) Methods are outlined for testing all intrinsic factor preparations with the same amount of tracer vitamin B_{12} as will be incorporated commercially. More sensitive comparative tests of similar intrinsic factor preparations may be made using smaller amounts of $B_{12}Co^{60}$.

"(4) The literature is reviewed to determine which variations in technic might lead to the most reliable quantitation of intrinsic factor activity."

Some suggestsions are made in answer to the question of how the urinary excretion test should be standardized.

(1) *The Fasting State:* The patient should fast for at least two hours after the oral administration of $B_{12}Co^{60}$ and intrinsic factor concentrates.

(2) *Method of Giving $B_{12}Co^{60}$ and Intrinsic Factor Concentrates:* It would seem advantageous to mix the $B_{12}Co^{60}$ and intrinsic factor concentrate in solution before administration rather than to give the intrinsic factor separately in a capsule. Uniform contact of intrinsic factor with the B_{12} is thus insured.

(3) *Dose of $B_{12}Co^{60}$:* For any given study it seems most important that a uniform dosage of $B_{12}Co^{60}$ in terms of B_{12} weight be used throughout; 2.0 μg. has the advantage of a greater accumulated experience, but 1.0 μg. has the recommendation of a greater percentage excretion for more accurate measurement. With this dose, percentage is readily converted into absolute terms. The authors have now adopted the policy of clinical diagnostic testing and comparison of similar intrinsic factor concentrates using 1.0 μg. doses. For minimization of binding artefacts in assessing the clinical potency of dissimilar intrinsic factor preparations they prefer 15.0 μg. doses despite the relatively small recovery of radioactivity in the urine.

(4) *Time and Amount of First Parenteral Dose:* It would seem that Schilling's original schedule of 1,000 μg. subcutaneously two hours after the oral material should be followed. For clinical screening we have found satisfactory results when this injection is given simultaneously with the oral material.

(5) *Collection of Urine and Subsequent B_{12} Injections:* Fractionation has no advantage over a single twenty-

four-hour urine collection. It would appear that for best quantitative results at least two and preferably three successive days with parenteral B_{12} administration and twenty-four hour urine collection would be desirable for each intrinsic factor test.

(6) *Value to be Reported:* It is important that the oral dose be clearly stated in micrograms of vitamin B_{12}.

(7) *Frequency of Tests:* A number of authors have noted that heavy loading of the system with vitamin B_{12} will inhibit the intestinal absorption of $B_{12}Co^{60}$. This being the case, it would be advantageous to allow a reasonable interval in which no large doses of vitamin B_{12} are given before subsequent tests are performed. Blood levels of vitamin B_{12} are elevated as long as forty-eight hours after a large parenteral dose, but are not excessively high. It is recommended that an interval of at least two days elapse after the last large injection of B_{12} before a test is initiated.

Three graphs; 1 table.

SYDNEY F. THOMAS, M.D.
Palo Alto, Calif.

Time Pattern of Vitamin $B_{12}Co^{60}$ Urinary Excretion in Man After Oral Administration and Parenteral "Flushing." William R. Best, Wendell A. Landmann, and Louis R. Limarzi. Blood **11:** 352–356, April 1956. (University of Illinois College of Medicine, Chicago, Ill.)

Serial urine collections in a number of patients with pernicious anemia given 2 μg. $B_{12}Co^{60}$ orally, followed in two hours by 1,000 μg. of non-radioactive vitamin B_{12}, showed little urinary radioactivity at any time. When these tests were repeated, wth a potent oral dose of intrinsic factor concentrate, there was little activity during the first four hours. Peak excretion rates occurred most commonly between six and twelve hours after ingestion of radioactive B_{12}, sometimes even later. The time of peak excretion was fairly characteristic for the individual. Secondary peaks occasionally occurred, and after twenty-four hours only slight radioactivity usually remained. It is postulated that the delayed peak is related to the time it takes for B_{12} to be transported in the intestine to the point of absorption, or to the duration of the intracellular metabolic processes of absorption. For most purposes the use of fractional urinary collections is not necessary.

Three graphs; 1 table.

SYDNEY F. THOMAS, M.D.
Palo Alto, Calif.

The Incorporation of N^{15}-Labeled Glycine in the Plasma Protein, Plasma Phospholipids, Blood Non-protein Nitrogen, and Splenic Tissue in Man. D. S. Amatuzio, P. S. Hagen, and R. L. Evans. J. Lab. & Clin. Med. **47:** 241–247, February 1956. (Department of Medicine, University of Minnesota, Minneapolis, Minn.)

A state of dynamic equilibrium with a constant exchange of nitrogen between various tissues has been accepted and supported with isotopic amino acid data. The incorporation of amino acids into plasma protein has been previously demonstrated with the use of C^{14} glycine, S^{35} methionine, and N^{15} glycine. The present study adds to these observations measurements of plasma protein, plasma phospholipid, and non-protein nitrogen after the feeding of labeled glycine to 2 adult men.

Shortly after the feeding of the labeled glycine, the isotope concentration in the phospholipids, non-protein nitrogen, and the blood plasma proteins rose rapidly to a maximum and then gradually declined. The disappearance rates of the atom per cent N^{15} excess in plasma protein were approximately 43, 13, and 1.8 per cent per day. The fast rate of disappearance may represent body distribution and the initial absorption, while the slower rate may represent body conservation of nitrogen. The disappearance rate of the atom per cent excess of nitrogen in plasma phospholipid was of a similar magnitude.

Four graphs.

Studies on Copper Metabolism. XXI. The Transfer of Radiocopper Between Erythrocytes and Plasma. J. A. Bush, J. P. Mahoney, C. J. Gubler, G. E. Cartwright, and M. M. Wintrobe. J. Lab. & Clin. Med. **47:** 898–906, June 1956. (University of Utah College of Medicine, Salt Lake City, Utah)

The authors undertook to study the uptake and release of radiocopper (cupric^{64} acetate) from and into plasma by erythrocytes. Eight normal adult persons served as subjects, 5 for *in vivo* studies, 3 for *in vitro* studies.

It was demonstrated that the copper is taken up rapidly by erythrocytes under both *in vivo* and *in vitro* conditions. Red cells exposed either *in vivo* or *in vitro* to radiocopper for fifteen to thirty minutes and then incubated with plasma allow 30 to 60 per cent of the activity to pass into the plasma. When, on the other hand, exposure is for twenty-four hours followed by incubation with plasma, only 5 to 15 per cent of the radioactivity passes into the plasma. When copper was added to plasma, no significant activity could be detected in ceruloplasmin.

The possible metabolic pathways of copper in the plasma and erythrocytes are discussed.

Five graphs; 1 diagram; 1 table.

Labeling Human Erythrocytes with Radiochromium. Milton Cooper and Charles A. Owen, Jr. J. Lab. & Clin. Med. **47:** 65–71, January 1956. (M. C., Mayo Foundation, Rochester, Minn.)

In order to evaluate erythrocyte survival or alimentary tract bleeding, labeling of human erythrocytes was done by the addition of radiochromium to whole blood, and observations were made with variations in anticoagulant, temperature, time, hematocrit value, and order of mixing the components. Labeling was halted at will by addition of ascorbic acid to the reaction mixtures.

The degree of labeling was found to vary with the anticoagulant used from least to most effective, as follows: heparin, sodium citrate, Baxter brand of citrate-dextrose, and the citrate-dextrose preparation of Strumia (Blood **10:** 429–440, 1955).

Labeling was achieved much more rapidly at 37° C. than at 26° C. in citrate-dextrose solution, but after fifteen minutes the difference was slight with the Strumia preparation.

The lower the hematocrit value, the less efficient was the Cr^{51} labeling.

In 7 normal young adults, the 50 per cent erythrocyte-survival time as determined by radiochromium labeling varied between twenty-eight and thirty-seven days. This is in excellent agreement with published values

derived from studies in which other labeling technics and methods of assay were employed.

Five graphs; 1 table.

Analysis of Mixtures of Radioactive Isotopes by γ-Ray Measurements. Application of the Method to Ac^{227}, Th^{227}, and Ra^{223}. D. S. Anthony, J. E. Campbell, G. R. Hagee, and E. S. Robajdek. Radiation Res. 4: 286–293, April 1956. (D. S. A., Department of Chemistry, University of Florida, Gainesville, Fla.)

A general method for the determination of the components of a mixture of radioactive isotopes by measurement of the growth and/or decay of γ-ray emission is presented. Application of the method to the determination of Ac^{227}, Th^{227}, and Ra^{223} in mixtures is described step by step. The method automatically compensates for differences in the γ-ray energy spectrum of the nuclei measured, requires almost no sample preparation, and is applicable to an enormous range of physical or chemical forms of sample. Sensitivity is sufficient for determination of 10^{-2} μc or less of γ-ray emitting isotopes.

The Los Alamos Human Counter. Ernest C. Anderson, Robert M. Schuch, James D. Perrings, and Wright H. Langham. Nucleonics **14:** 26–29, January 1956. (Los Alamos Scientific Laboratory, University of California, Los Alamos, N. Mex.)

The "human counter" described in this paper is a gamma detector having a sensitivity of 5×10^{-10}c for a nuclide emitting one gamma ray per disintegration. The sample capacity of the instrument is 300 lb. The sensitivity is such that the natural K^{40} content of the human body (about 10^{-8} gamma ray curies) can be measured to a precision of 5 per cent in two minutes of counting time.

The human counter consists of a cylindrical tank 72 in. in length by 30 in. in diameter, with a thin-walled tube 18-in. in diameter running down the axis. The annular space between the tube and tank wall is filled with 140 gallons of scintillation solution.

Scintillations are detected by 108 photomultiplier tubes inserted through the outer wall of the tank. The central cavity accommodates the subject or sample to be counted. The whole assembly is surrounded by a 5-in.-thick, 20-ton lead shield.

Preliminary studies were made of the variation of potassium content of man as a function of body weight and age. Measurements were made on a group of both sexes from four to seventy-five years old. In spite of considerable scatter in the data certain trends are evident. In children there was no significant difference between boys and girls, the body activity being directly proportional to body weight within the experimental error. The adult points, however, seemed to scatter downward in activity from the extrapolated line passing through the points for the children, presumably representing the addition of fat to the basic frame. The average activity for women was significantly below that of men, and the range of variation among adults was larger than experimental error.

A summary of the authors' results gives the average potassium content of men as 200 gm. and that of women as 170 gm. These figures are about 25 per cent greater those those given by other workers.

Several other major research programs are planned for the human counter. Among them are human retention of gamma emitting fission products, counting beta emitters by bremsstrahlung, natural body gamma activities, and further studies of body potassium content.

Two photographs; 2 drawings; 1 table.

Ross Garrett, M.Sc.
Memorial Center, New York

RADIATION EFFECTS

Dosages in Diagnostic Roentgenology. R. Jaṅker. Röntgen Blätter **9:** 137–152, May 1956. (In German) (Baumschulallee 12/14, Bonn, Germany)

Screen brightness and picture contrast during roentgenoscopy are determined by the exit dose, which in turn is proportional to the entrance dose. Patient exposure may be evaluated by adding back-scatter to entrance/air dose, *i.e.*, arriving at the skin dose. The relationship skin dose/exit dose (SD:ED) expresses both the radiation hazard and the image quality expected under given conditions. For the average chest roentgenoscopy, SD:ED is about 50, but for thicker chests, and for the abdomen, the ratio is even less favorable; in terms of skin dose, even a slight increase in screen brightness is certainly overpaid. A higher kilovoltage improves brightness by bringing up the exit dose, while added filtration decreases the skin dose. Thus, by adequately stepping up both the kilovoltage and filtration, one may obtain satisfactory brightness with a comparatively lesser exposure. Duration of roentgenoscopy, decrease in brightness of the "aging" and/or obsolescent screen, incomplete dark adaptation, size of the diaphragmatic aperture, etc., will all tend to increase the skin dose. At 60 kv and 3 ma, the SD:ED is 124 with half-wave but only 76 with full-wave rectification. This explains why roentgenoscopy with "small" machines, as performed by non-radiologists, is more hazardous in terms of patient exposure. With a lessened target-skin distance, the result may become disastrous: for the average half-wave machine, the skin dose at 35 cm. (minimum TSD recommended in this article) is 20 r/min; at 20 cm. it is 60 r/min; at 7 cm. it reaches 500 r/min. According to the author, no diagnostic examination should exceed 120 r to the patient's skin and this dose should not be repeated before six weeks.

In roentgenography, the average "chest" (SD:ED 20) attenuates the useful beam as much as 0.35 mm. Cu, while the average "stomach" (SD:ED 200) corresponds to 1.5 mm. Cu. The skin dose for a chest roentgenogram is 0.05–0.12 r, for a stomach 1.5–5.0 r, for a frontal spine view 2.0–5.0 r, and for a lateral spine 4.0–9.0 r. The figures are higher for photoroentgen examinations: if the skin dose produced by a conventional chest roentgenogram is equated with 1.0, a single exposure needed for the 70-mm. film will result in 8.65 times higher dosage.

A real hazard is offered by the serial examinations (angiocardiography) which, in a lateral projection, with 3 pictures per second for ten seconds, may raise the skin dose to as much as 88.5 r. The danger is just as great or greater in roentgencinematography. [Image intensi-

fiers would certainly operate with a considerably lesser exposure to the patient, but these are not discussed in the paper.] Adequate preventive measures, however, can keep the exposure to both patients and operators below the permissible level. For instance, special wood-lead panels around the patient on the angiocardiographic table permit the presence of the operator at a total of 25 monthly examinations in two planes, or 40 examinations in a single plane.

Fourteen tables; 3 photographs; 2 drawings.

E. R. N. GRIGG, M.D.
Cook County Hospital, Chicago

The Nature of Intestinal Radiation Death. Henry Quastler. Radiation Res. **4:** 303–320, April 1956. (Department of Physics, University of Illinois, Urbana, Ill.)

The author describes an attempt to follow the evolution of acute intestinal radiation death from the cellular or subcellular level to that of the whole organism. He tries to identify the critical event on the cellular level; to trace its effect through the biology of the tissue involved, the intestinal epithelium; to relate the tissue changes to responses of the whole intestine; and to see in what manner the changes in the organ are responsible for the death of the animal. He has tried, according to his own statement, to develop a picture which is coherent and unified at the risk that it may not be correct in some details. Only those features are included which, in the author's opinion, are needed to diagnose intestinal death and to interpret its mechanism. It is hoped that the interpretation will serve as a framework for additional studies of acute intestinal radiation death and as a guide for the recognition of intestinal components in radiation reactions which are not lethal or are lethal due to extraintestinal causes.

Acute intestinal radiation death is characterized by the following diagnostic features: (1) It occurs with doses of 1 to 10 kr. (2) The survival time is about three to five days and is nearly invariant with dose. (3) The target organ is the small bowel. (4) The distinctive pathology is loss of the epithelial lining of the intestine.

The earliest effect identified with certainty is the blocking of the production of viable cells in the generative zone of the intestinal epithelium; this effect is due to inhibition of mitosis and to cell abortion, the latter probably resulting from chromosomal damage. The decay of mature epithelial cells is delayed but, if the production of new cells is blocked for a sufficiently long time, the population of epithelial cells vanishes. This leads to denudation of the intestinal lining. Two feedback controls postpone the onset of denudation until almost all cells are gone, namely, spreading of the remaining cells and contraction of the villi. Death follows denudation, the ultimate causes probably being action of proteolytic enzymes and/or loss of water and electrolytes. Bacteremia is not a major factor.

Nine figures.

Efficacy of Hematopoietic Protective Procedures in Rats X-Irradiated with Intestine Shielded. Marguerite N. Swift, S. Tom Taketa, and Victor P. Bond. Radiation Res. **4:** 186–192, March 1956. (U. S. Naval Radiological Defense Laboratory, San Francisco, Calif.)

Spleen shielding during exposure and postexposure administration of spleen homogenate or bone marrow have been found less effective in rats than in mice in reducing whole-body radiation mortality. A similar species difference was reported in the response of rats and mice to regional fractionation of a whole-body radiation dose. Fishler et al. (Am. J. Physiol. **177:** 296, 1954. Abst. in Radiology **64:** 480, 1955) observed that bone marrow therapy is ineffective in rats receiving radiation doses sufficiently high to produce acute intestinal deaths, suggesting that marrow administration stimulates hematopoietic recovery only and does not specifically influence recovery from intestinal damage. On this assumption, the authors suggested that the species difference noted above might be explained at least in part on the basis of the relatively greater radiosensitivity of the intestinal tract in the rat as compared with that of the mouse. In order to make a valid comparison of the potentialities for recovery from hematopoietic damage in the rat and mouse, elimination of the intestinal injury component in the two species was clearly indicated. The authors have therefore evaluated the effects of bone marrow injection and spleen or leg shielding on thirty-day mortality in rats exposed with the gastrointestinal tract exteriorized and shielded.

A postirradiation dose of 60 mg. of bone marrow per 100 gm. of body weight was found to be slightly more effective than 30 mg. per 100 gm. in reducing mortality in rats given 1,200 r with the gastrointestinal tract shielded. No further protective effect was obtained with 90 mg. per 100 gm.

Shielding of the spleen or one hind leg during 1,200-r irradiation, with the gastrointestinal tract also shielded, markedly reduced mortality; however, this protection was significantly diminished if the spleen was extirpated or if the previously shielded leg was irradiated with 1,200 r, after an interval as long as three days.

Comparison of the data obtained with studies in whole-body-exposed mice shows that (1) considerably more bone marrow is still required for optimal protective effect in the rat, even though intestinal damage is eliminated, and (2) the length of time required for shielded hematopoietic tissue to remain present and/or functional, in order to confer maximal protection, is significantly longer in the rat. It is concluded that the lesser effectiveness of spleen and marrow shielding or therapy in the whole-body irradiated rat as compared to the mouse cannot be explained entirely on the basis of differing gastrointestinal radiosensitivities in the two species.

Three graphs.

Comparative Effectiveness of Several X-Ray Qualities for Acute Lethality in Mice and Rabbits. Douglas Grahn, George A. Sacher, and Howard Walton, Jr. Radiation Res. **4:** 228–242, March 1956. (Division of Biological and Medical Research, Argonne National Laboratory, Lemont, Ill.)

The relationship of acute lethality and depth-dose distribution in mice and rabbits exposed to x-rays ranging from 80 to 250 kvp has been studied. Increases in the LD 50 doses was found to occur in both species with decreasing x-ray energy. On the basis of dosimetry in homogeneous phantoms, the LD 50 values expressed as mean body doses continue to increase instead of holding constant, indicating that the dose-reduction principle does not hold.

Two alternative statistical hypotheses are considered: a constant-slope (or subtractive dose) hypothesis and a combination of the dose reduction and constant-slope hypothesis. Qualitative consistency of the data with

the results of experimental partial-body shielding is indicated. The concept of the subtractive dose is confirmed in part by data from partial-body irradiation, wherein more favorable hematopoietic recovery acts to enhance survival. Since dosage declines significantly with depth at the lower energies, a degree of innate partial-body shielding must exist even after whole-body exposure, thereby favoring survival through a reduction of the dose to the tissues of the hematopoietic system, particularly the bone marrow. According to available evidence, the latter would be additionally shielded, due to the high absorption of low-energy x-rays by bone.

Six graphs; 5 tables.

The Prompt Effects of Whole-Body Irradiation at a High Dose Rate on the Electroencephalogram of Monkeys. Phillips M. Brooks. Radiation Res. **4:** 206–216, March 1956. (Department of Radiobiology, USAF School of Aviation Medicine, Randolph AFB, Texas)

The author describes an investigation of the effects of whole-body irradiation on the electroencephalogram of urethan-anesthetized rhesus monkeys irradiated at a dose rate of 1,000 r/min. from a Ba^{140}-La^{140} multikilocurie source. Half-value layers for radiation of this energy (1.6 MEV) are approximately 52 mm. of aluminum and 12 mm. of lead. The effects are considered *prompt*, since they occurred within one hundred minutes from the beginning of the exposure. Two animals served as controls; 1 animal received a dose of 1,000 r; 2 animals, 2,500 r; 2 animals, 10,000 r; 3 animals, 30,000 r.

In 8 animals out of 11 a definite decrease in the brain electrical activity occurred by the end of one minute of irradiation, and in 9 out of 11 by the end of the second minute of exposure; this loss appeared to be a direct effect of radiation on neural function. The initial depression was followed by a period of recovery which, in several instances, took place during irradiation.

With a radiation dose up to 2,500 r, the recovery of brain electrical activity after the initial depression approached the pre-exposure level, where it remained for the rest of the one-hundred-minute observation period.

With radiation doses of 5,000 r or more, the electroencephalographic index after the recovery phase and during the remaining portion of the observation period fell off, either abruptly or gradually.

The general change in the electroencephalographic pattern was a decrease in wave frequency and voltage. Often the frequency became arrhythmic and in several instances was very slow and arrhythmic with very low voltage.

Two distinct effects in the electroencephalogram were observed: first, an immediate but transient suppression of electrical activity, which appears to be the result of direct action of the radiation on neural function; second, a delayed but more extreme and lasting loss of activity which can be assumed to be mainly an indirect effect resulting from the direct radiation effects on other physiological functions, which in turn influence the electroencephalogram.

Action of X-Rays on Mammalian Cells. Theodore T. Puck and Philip I. Marcus. J. Exper. Med. **103:** 653–666, May 1, 1956. (University of Colorado Medical Center, Denver, Colo.)

Experiments are reported which demonstrate quantitatively the effects of high-energy x-radiation on the reproductive capacity of single cells derived from a human cervical carcinoma (HeLa). The conditions were such that 100 per cent of the unirradiated cells could reproduce in isolation to form macroscopic colonies. Survival was defined as the ability to form such a colony within fifteen days.

Four radiosensitive processes were distinguishable:

1. Loss of the ability of single cells to form a macroscopic colony: This reproductive function possesses a shoulder in the neighborhood of 75 r, after which the surviving population is reduced by a factor of 37 per cent for every additional 96 r. Radiosensitivity of this order is tens to hundreds of times greater than that of any microorganism for which the equivalent function has been studied. It was also observed that cells injured mortally in the dose range up to 600 r retain the ability to multiply for one to five generations.

2. Slowing of growth among the survivors: This effect is more difficult to measure, but is distinct at doses of 100 to 200 r.

3. Damage to the reproductive apparatus, at doses greater than 600 r: Cells sustaining this dosage rarely divide at all. An appreciably large proportion of the cells continue to grow, however, forming giants, so that a considerable part of the metabolic equipment remains functional.

4. Disappearance of some of the irradiated cells at higher doses, presumably by disintegration. This action of radiation is by far the least effective, since even after 10,000 r, 5 to 10 per cent of the original cell inoculum are recoverable as giants.

Evidence is presented which suggests that the lethal effect is due to a radiation-induced genetic defect which, however, cannot be a simple single-gene inactivation. The locus of the action could be chromosomal.

Five photographs; 2 photomicrographs; 2 graphs.

Effects of Hydration on X-Ray Sensitivity in *Hordeum*. Richard S. Caldecott. Radiation Res. **3:** 316–330, November 1955. (Agronomy and Plant Genetics Department, University of Minnesota, St. Paul, Minn.)

Prior to irradiation the water content of seeds of barley has been modified by (1) storage at different relative humidities, (2) steeping for sixteen hours at 0° C., followed by periods of desiccation, and (3) steeping at 0° C. and 22° C. for different intervals of time.

Pooling the data from all studies clearly shows that the sensitivity of barley seeds to x-rays, as measured by inhibition of seedling growth and the frequency of chromosomal aberrations, decreases as the water content of the embryo increases from about 4 to about 8 per cent. At this upper level, a plateau is reached, and further addition of water to the embryo (up to 60 per cent) results in no additional modification of sensitivity, providing that cellular activity is inhibited by low temperatures. The data suggest that previous ideas concerning the effects of hydration in substantiating the indirect action hypothesis of the action of radiation in cellular systems should be modified.

Author's Abstract

Skin Replacement for Severe Radiation Dermatitis of the Face. John J. Conley. Surg., Gynec. & Obst. **102:** 581–587, May 1956. (St. Vincent's Hospital, New York, N. Y.)

The changes that occur in the postirradiated skin

pass through the gamut of mild atrophy to severe fibrosis, ulceration, and cancerous degeneration. The degree and rate of degeneration depend upon the amount and type of irradiation used, the time interval following therapy, and the sensitivity of the skin. Keratoses, irradiation ulcers, and localized basal-cell cancers comprise the vast majority of the late complications of this condition. They are successfully treated by electrodesiccation or surgical removal and repair. Occasionally, sarcoma arises in the irradiated fibrous tissue, and it is successfully treated by surgical excision and repair. The serious aspects of this condition are associated with development of primary squamous-cell cancer or the development of squamous-cell cancers in radiation ulcers. When this tendency repeats itself or becomes widespread on the face, the serious danger of the local disease is compounded by the potential for local or generalized metastases.

This paper, as the title denotes, deals with the surgical aspects of these more serious conditions. The author lists the indications for extensive replacement of the skin of the face as follows: (1) post-irradiation dermatitis and ulceration with a high potential for squamous-cell cancer; (2) multiple and repetitive squamous-cell cancers of the face; (3) disseminated interepithelial basal-cell cancer. The seriousness of multiple or repetitive squamous-cell cancers and degeneration in post-irradiation dermatitis is emphasized.

Three surgical methods of treatment are described. All are single-stage operations designed to replace the epithelial covering of the face by either pedicle flaps rotated from the neck and scalp or the application of free-skin grafts.

Nine photographs; 3 drawings.

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Medical Care of Wounds Contaminated with Radioactive Materials. Asher J. Finkel and Earl A. Hathaway. J.A.M.A. 161:121–126, May 12, 1956. (A. J. F., Box 299, Lemont, Ill.)

Radioactive materials may be accidentally introduced into the body through a variety of pathways. The resulting radiotoxicity will depend on the absorption rate, amount of activity, solubility, etc., of the radioisotope. If large amounts of the material gain access into the organism, acute radiation sickness, marked by nausea, vomiting, diarrhea, and reduced food and water intake, will follow. The acute effects may linger to produce a reduction in gonadal, gastric and intestinal activity, and depression of the hematopoietic system. Later findings in the acute radiation syndrome are ushered in with vasomotor collapse, emaciation, alopecia, and the clinical evidences of pancytopenia—anemia, hemorrhages, and infection. Delayed toxic effects may appear in survivors of the acute radiation syndrome or may result from the internal deposition of slowly excreted long-lived isotopes that are not present in sufficient amounts to produce acute illness.

The care of trauma leading to deposition of radiotoxic matter beneath the skin differs from ordinary surgical care in several respects. Shaving of the area, if necessary, is deferred until after a long period of vigorous scrubbing by detergents rather than soap. At present isotonic sodium chloride, or its equivalent, is the only solution known to be safe for irrigation but the substitution of a chelating (edathamil) or a complexing (citrate ion) irrigant where the resultant compound will not be likely to be absorbed before it can be washed from the wound may eventually be found to have advantages. In addition to the débridement of devitalized tissue, it may be necessary to sacrifice physiologically unimpaired tissue if the hazard of further absorption outweighs the concern of acceptable restoration of tissue continuity and function. To locate radioactive material below the wound surface there are sensitive scintillometers, in the form of probes containing a photomultiplier tube and preamplifier unit in the handle.

Medically, once the presence of circulating radiotoxins has been established, zirconium citrate used intravenously leads to the formation of a zirconium-radiotoxin complex that is excreted in the urine. Drawbacks to this therapy have been the toxic side-effects of zirconium and the difficulty in autoclaving zirconium citrate for intravenous use.

The prompt intravenous use of the non-toxic chelating agent, edathamil calcium-disodium, has resulted in a substantial lowering of circulating radiotoxic heavy metals in animals, leading to diminished deposition in bone without appreciably affecting the soft-tissue load. This increased excretion can be measured by monitoring the urine. The drug was also effective in a laboratory technician who suffered a hand laceration contaminated with plutonium.

Simple dilution by forcing fluids may result in markedly shortening the biological half-life of tritium, Na^{24} and K^{42} merely by increased diuresis.

Various plans with architectural details are presented for the decontamination of exposed patients within hospitals but sufficiently isolated to prevent contamination of other patients and unprotected personnel.

Two photographs; 4 diagrams.

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